

**Anna Kattainen**

# **CARDIOVASCULAR DISEASES AND FUNCTIONAL CAPACITY**

**Prevalence, secular changes and predictive value**

**ACADEMIC DISSERTATION**

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of Medicine of the University of Helsinki, for public examination  
in the small auditorium of the Haartman Institute,  
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## ABSTRACT

The main objective of this study was to examine 20-year time trends in the disability burden caused by coronary heart disease (CHD) in Finland. To do this, time trends in the prevalence of CHD and disability were examined, and the proportion of change in overall disability in Finland due to changes in CHD prevalence and CHD-related disability were estimated. The impact of different cardiovascular diseases on disability and the need for help among elderly Finns was examined, as was the importance of disability as a predictor of mortality in men and women suffering from CHD.

Data from three population-based health examination surveys with high participation rates (Mini-Finland Health Survey in 1978–1980, FINRISK-97 Senior Survey in 1997 and Health 2000 Survey in 2000–2001) were used. The Mini-Finland Health Survey and Health 2000 Survey represented the Finnish population aged 30 years and over, and the FINRISK-97 Senior Survey included persons aged 65–74 years from two areas of Finland. In the substudies of this thesis, persons aged 45 years or more were included. Mortality of participants in the Mini-Finland Health Survey was followed until the end of 1994. The main statistical methods used in the studies were logistic regression analysis and the Cox proportional hazards model.

Cardiovascular diseases (in particular cerebrovascular diseases and in women, also myocardial infarction and heart failure) were strongly associated with disability in persons aged 65–74 years. These diseases were also quite common, and thus they accounted for a third of population level disability in men and a fourth in women in this age group. Disability increased mortality in men regardless of the presence of CHD, and in women without CHD. Prevalence of CHD has decreased among middle-aged Finns and increased among men and women aged 75 years or over from 1978–1980 to 2000–2001. Prevalence of disability has decreased in men and women under the age of 75 years. The decrease was evident in men with and without CHD and in women without CHD, but no significant decline was observed in women with CHD. Up to 25% of the decrease in disability in Finland during the past 20 years was estimated to be due to CHD-related changes. In men aged 75 years or more and in women aged 65 or more, however, CHD-related disability has increased rather than decreased, although overall disability has slightly decreased.

The burden of CHD has not disappeared but shifted to older age groups. Due to the growing number of elderly people with CHD, disability associated with the disease is likely to become a growing social and health burden to the community. In particular, elderly women with myocardial infarction need more attention to improve their health and functional capacity, and to prevent the burden caused by CHD and its consequences from increasing.



## ABBREVIATIONS

ADL	activities of daily living
AP	angina pectoris
BMI	weight/height <sup>2</sup> , kg/m <sup>2</sup>
BP	blood pressure
CHD	coronary heart disease
CI	confidence interval
CVD	cardiovascular disease
DPB	diastolic blood pressure
ECG	electrocardiogram
IADL	instrumental activities of daily living
ICD	International Classification of Diseases
ICF	International Classification of Functioning, Disability and Health
ICIDH	International Classification of Impairments, Disabilities and Handicaps
MI	myocardial infarction
MMSE	Mini Mental State Examination
N	number
NYHA	New York Heart Association
OECD	Organization for Economic Co-operation and Development
OR	odds ratio
RR	relative risk
SBP	systolic blood pressure
WHO	World Health Organization

## LIST OF ORIGINAL PUBLICATIONS

The thesis is based on the following articles referred to in the text by their Roman numerals.

- I. Kattainen A, Reunanen A, Koskinen S, Martelin T, Knekt P, Aromaa A. Secular changes in prevalence of cardiovascular diseases in elderly Finns. *Scandinavian Journal of Public Health* 2002;30:274–280.
- II. Kattainen A, Koskinen S, Reunanen A, Martelin T, Knekt P, Aromaa A. Impact of cardiovascular diseases on activity limitations and need for help among older persons. *Journal of Clinical Epidemiology* 2004;57:82–88.
- III. Kattainen A, Reunanen A, Koskinen S, Martelin T, Knekt P, Sainio P, Härkänen T, Aromaa A. Secular changes in disability among middle-aged and elderly Finns with and without coronary heart disease from 1978–1980 to 2000–2001. *Annals of Epidemiology* (in press).
- IV. Kattainen A, Reunanen A, Koskinen S, Martelin T, Knekt P, Aromaa A. Disability predicted mortality in men but not women with coronary heart disease. *Journal of Clinical Epidemiology* (in press).

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# 1 INTRODUCTION

Cardiovascular diseases (CVD) are important causes of illness, disability, and death (Wenger 1988; Murray et al. 1996; Sans et al. 1997). Although mortality from CVD has decreased around 60% during the last 20 years in middle-aged Finns, in 2002 40% of all deaths in men and 45% in women in Finland were caused by CVD (Statistics Finland 2003a). The decrease in mortality has been greatest among the middle-aged, but there has also been a marked decrease in the elderly (Kesteloot et al. 2002; Martelin et al. 2003; Statistics Finland 2003a). Incidences of acute coronary heart disease (CHD) events and stroke in the middle-aged Finnish population have decreased, but to a lesser extent than mortality (Numminen et al. 1996; Salomaa et al. 1996a; Statistics Finland 1996; Salomaa et al. 2003). Incidence of stroke has also decreased in the elderly (Numminen et al. 1996), but except for some limited information based on registers collected for administrative purposes, there are no valid data on how the incidence of acute CHD events in the elderly has changed in Finland (National Public Health Institute; Salomaa et al. 1996b; Salomaa et al. 1996c). Data concerning secular changes in the incidence and prevalence of heart failure are scarce.

The dramatic decrease in mortality, over 70% during the last 25 years (Statistics Finland 1998; Statistics Finland 2003a), and the marked decrease in the incidence of acute CHD events among middle-aged Finns, may tempt one to draw the conclusion that the prevalence of CHD has also decreased, and that these reductions have occurred also among elderly persons. However, the annual number of hospital treatment days with CHD diagnoses increased rather than decreased among elderly persons in the 1980s (Pyörälä et al. 1994). An important aim of this study was to clarify secular changes in the prevalence of CHD and also other CVDs among elderly persons.

The population in Finland, as in many other developed countries, is aging (World Population Ageing: 1950–2050 2001). The number of individuals aged 65 years or more will increase by over 70% from 2003 to 2030 (Statistics Finland 2003b). The incidence and prevalence of CVD increase markedly with age, and so does the prevalence of disability (Guralnik et al. 1993; Andersen-Ranberg et al. 1999). It may therefore be assumed that the burden on the health-care system resulting from CVD and related disability will increase as the population ages. The burden of CVD on society depends on the incidence and prevalence of CVD in each age group, the degree of disability caused by CVD, and the age structure of the population. In order to assess the future burden to health care, social, and rehabilitation services due to CVD, it is important to examine how the functional ability of persons suffering from these diseases has changed, and to study the secular changes in prevalence.

This thesis is based on three cross-sectional population-based health examination surveys conducted in Finland from 1978 to 1980, in 1997, and from 2000 to 2001, including follow-up results of the first survey. The aim of these surveys was to estimate the prevalence of chronic diseases, activity limitations, and the need for care in the Finnish population. This thesis considers various CVDs, but concentrates on CHD. Secular changes in the prevalence of various CVDs and in the prevalence of disability among persons suffering from CHD are described. The impact of specific CVDs on activity limitations and the need for help in elderly Finns is examined, as well as the importance of disability as a predictor of mortality in persons with and without CHD. Secondary objectives were to reveal possible age group and gender differences.

## 2 REVIEW OF LITERATURE

### 2.1 Cardiovascular diseases

CVDs have for a long time been among the major public health concerns in Finland. Although CVD mortality has declined considerably (Martelin et al. 2003), they still account for over 40% of all deaths in Finland (Statistics Finland 2003a), as in most Western countries. In eastern European countries this percentage is much higher (Kesteloot et al. 2002). In 2002, 9 585 deaths in men and 11 460 deaths in women in Finland were due to these diseases (Statistics Finland 2003a). The most common CVDs are hypertension, CHD, heart failure, and cerebrovascular disorders. Data on the prevalence of chronic CVD, especially on changes in CVD prevalence in the elderly in Finland, is limited. According to the basic report of the recent Health 2000 Survey, the prevalence of CHD has declined among working-aged Finns during the past 20 years, but among persons aged 65 years or over the decline has been smaller (Aromaa et al. 2002). It is uncertain how the burden of CVD and related disability has developed among the elderly.

#### 2.1.1 Coronary heart disease

##### *2.1.1.1 Definition and measurement*

The term CHD refers to the consequences of oxygen deficiency in the myocardium caused by the decrease or complete interruption of the blood supply, generally originating from reduced blood flow from coronary arteries and usually caused by atherosclerotic changes (Miles et al. 1990). Sudden death, myocardial infarction (MI), and angina pectoris (AP) are the most common manifestations of the disease. Silent ischaemia and silent electrocardiogram (ECG) changes are also manifestations of CHD.

In population studies, the prevalence of previous MI and AP has commonly been assessed by interview questions relating to known diseases, clinical examination and physician diagnosis, or by a standardized World Health Organization (WHO) questionnaire (Rose et al. 1968; Reunanen et al. 1983). Resting ECG is the most common objective measurement of CHD applied in population studies. The changes related to CHD in ECG are usually coded according to the Minnesota code suggested by the WHO (Rose et al. 1968). National registers of hospital discharge diagnosis and causes of death on death certificates have also commonly been utilized to assess the occurrence of CHD (Joensuu 1989; Mähönen et al. 1999; Mähönen et al. 2000). In MI registers, the events are classified on the basis of symptoms, cardiac enzymes, serial Minnesota coding of ECGs, and in fatal cases autopsy findings and history of CHD (Romo 1972; Tuomilehto et al. 1992;

Salomaa et al. 2003). The serious outcomes of CHD (acute MI and fatal CHD) used in MI registers and in the WHO MONICA Project (Tuomilehto et al. 1989; Tunstall-Pedoe et al. 1994) can be defined more accurately than chronic CHD at the population level. Procedures commonly used in clinical diagnostics, such as exercise ECG and echocardiograph of the myocardium, have not been widely used in epidemiology due to their cost and practical problems.

Some 20 to 30 years ago only standardized symptom questionnaires and resting ECG-findings were thought to be acceptable methods in epidemiological studies of CHD, and clinical diagnoses were thought to vary too much according to the examining physician (Rose et al. 1968; Reunanen 1977; Reunanen et al. 1983). Considering AP, good agreement between the WHO chest pain questionnaire and a doctor's independent diagnosis has been found among the elderly (Dewhurst et al. 1991).

Symptomatic CHD can be defined on the basis of disease history obtained from examinees, AP symptoms, and ECG findings. Agreement between the results of a health interview and a health examination has been shown to be good in the detection of CVDs (Heliövaara et al. 1993). There was substantial agreement between self-reported AP and MI in a questionnaire survey and data from medical records among Finnish men and women (Haapanen et al. 1997). In addition, in a British study the level of agreement between self-report and medical record was substantial for doctor-diagnosed angina, and very high for doctor-diagnosed ischaemic heart disease (angina or MI) in middle-aged and elderly men (Lampe et al. 1999).

#### *2.1.1.2 Occurrence and secular changes*

Although CHD mortality has decreased around 70% during the last 25 years among middle-aged Finns (Valkonen et al. 1993; Salomaa et al. 1996a; Statistics Finland 1998; Salomaa et al. 2003; Statistics Finland 2003a), over a quarter of all deaths in Finland were due to CHD in 2002 (Statistics Finland 2003a). The decrease has been greatest among the middle-aged but there has also been a marked decrease in the elderly (Pyörälä et al. 1994; Salomaa et al. 1996a; Statistics Finland 1996; Kesteloot et al. 2002; Statistics Finland 2003a). In an international comparison, CHD mortality among men in Finland was the highest in the world during the 1960s and early 1970s, while the figure for women was high but not the highest (Pisa et al. 1982). The situation has improved, but male CHD mortality still remains high compared to most other western countries (Uemura et al. 1988; Thom et al. 1994; Sans et al. 1997; La Vecchia et al. 1998; Aromaa et al. 1999). The mortality and incidence of acute CHD events has been much higher in eastern and northeastern Finland than in southwestern Finland throughout the period for which

reliable data are available (Romo et al. 1982; Joensuu 1989; Koskinen 1994; Koskinen 1995; Salomaa et al. 1996b; Aromaa et al. 1999).

The incidence of acute CHD events in the middle-aged Finnish population has decreased (Salomaa et al. 1992; Immonen-Räihä et al. 1996; Salomaa et al. 1996a; Salomaa et al. 2003), but markedly less than mortality. Incidence of acute CHD events has also declined in other western European countries, whereas this development has not been as favourable in many eastern European countries, where increasing incidence rates have even been reported (Tunstall-Pedoe et al. 1999). There are no reliable data for how the incidence of acute CHD events in the elderly has changed in Finland. According to the national hospital-discharge register, the use of hospital beds due to CHD markedly increased in persons between 65 and 74 years of age, and particularly in persons aged 75 or more, during the 1980s (Palomäki et al. 1993; Pyörälä et al. 1994). The increased hospital use is largely a consequence of the increasing number of elderly individuals and the sharp increase in the number of very old individuals. It is also estimated that due to aging of the population, the increase in hospital treatment due to CHD will increase by a third during the period from 1996 to 2010 (Luoto et al. 1999; Luoto et al. 2000).

A rough estimate of the prevalence of CHD can be obtained from the numbers requiring drug treatment. In 2002, 102 985 men and 87 993 women were awarded the right to reimbursements for CHD medication costs. Of those aged 65 years or more, 22% of men had the right to special refunds in 2002, as did 15% of women (Data in files of the Social Insurance Institution, Finland 2002). The incidence of new rights to reimbursements for CHD medication costs has decreased during the past years among middle-aged and elderly men and women, despite a temporary increase in the late 1990s due to changes in the criteria for the right to the special refund for lipid lowering drugs (Reunanen, personal communication).

The main reasons for the fall in morbidity and mortality from CHD are changes in the known risk factors as well as improvements in treatment (Vartiainen et al. 1994b; Tunstall-Pedoe et al. 2000). The prevalence of high blood pressure (BP) and high serum cholesterol concentration has declined in middle-aged men and women. Smoking rates decreased among men from 1972 to 1997, after which they increased. Smoking among women increased until 1992, then levelled off, but increased again between 1997 and 2002 (Vartiainen et al. 1994a; Vartiainen et al. 2000; Laatikainen et al. 2003). The prevalence of daily smoking did not apparently change among persons aged 65–74 years from 1985 to 2001 (Sulander et al. 2001). However, the diet of the elderly population improved during the same time period (Sulander et al. 2003).

Survival after MI has improved during the past decades (Abrahamsson et al. 1998; Salomaa et al. 1999). Significant advances have been made in the treatment of CHD (Miettinen et al. 1999; Boersma et al. 2003). The supply of coronary operations has increased during past ten years (Hetemaa et al. 2003). In 1997, according to a Finnish study based on population-based MI registers carried out in defined geographical areas, 25% of men and 16% of women aged 35–64 years hospitalized with MI received a revascularization or a decision for revascularization within the 28-day period after the onset of symptoms (Salomaa et al. 2003). Improved treatment may be leading to increased utilization of health services at later stages in the disease process. It has been suggested that the improved survival in acute coronary syndromes has resulted in a growing population of patients with chronic cardiovascular conditions (Reitsma et al. 1999). On the other hand, bypass operations and coronary angioplasties have helped to relieve symptoms and to improve the functional capacity of people with serious CHD (The TIME investigators 2001; Henderson et al. 2003). Evidence of the impact of revascularization on survival among patients with chronic CHD is weaker (Blumenthal et al. 2000; The TIME investigators 2001; Henderson et al. 2003).

There are differences in the incidence, course, and clinical presentation of CHD between men and women. In an international comparison, both nonfatal and fatal CHD event-rates in women were low compared to those in men, particularly at working-age (Tunstall-Pedoe 1996). Differences in major cardiovascular risk factors explain part of the gender difference in CHD risk (Jousilahti et al. 1999). Any initial manifestation of CHD occurs about 10 years later for women than for men (Wenger 1998).

Acute MI and sudden death are the most usual manifestations in men, whereas AP is the most common manifestation in women (Reunanen et al. 1983; Kannel et al. 1992; Wenger 1998). Diagnosis of CHD is more difficult in women than in men (Kwok et al. 1999). Women with CHD report atypical symptoms more often than men. Unrecognized MI is more common in women than in men (Lerner et al. 1986).

MI is more common in men than in women, and the gender differences in the occurrence of AP are smaller (Lerner et al. 1986; Reunanen et al. 1991). It has been shown that women with AP have a more favourable outlook than men with similar symptoms (Reunanen et al. 1983; Murabito et al. 1993). Men with acute MI are more likely to die prior to hospitalization, but in many studies women have had higher hospital mortality rates than men (Wenger 1998; Wenger 2002). The gender differences in mortality after acute MI have lessened, but not disappeared, by controlling for older age and comorbidity (Wenger 2002). In Finland, however,



in-hospital mortality has been similar for men and women (Salomaa et al. 2003). Finnish men who were alive 28 days after their first MI were far more likely to have a fatal recurrent event than women despite a comparable numbers of events (Schreiner et al. 2001). There are gender differences in the care of CHD patients (Swahn 1998). In Finland, men with acute MI received revascularizations and thrombolytic treatment more often than women (Salomaa et al. 2003). Acute coronary events occur more commonly in middle-aged men, but the more chronic manifestations are more evenly distributed between men and women. With advancing age, the risk of CHD equalises between the genders (Tunstall-Pedoe 1996). Due to changes in population age structure, the numbers of women with CHD may even exceed that of men.

## 2.1.2 Cerebrovascular disorders

### 2.1.2.1 *Definition and measurement*

Cerebrovascular diseases include disorders of the arterial or venous circulatory systems which produce or threaten to produce injury to the central nervous system. The general term stroke describes the functional neurological injury (Plum et al. 1990).

In epidemiological studies, the diagnosis of stroke depends mainly on clinical data and is often far from exact in mild cases. Stroke is a group of vascular diseases of the central nervous system with a great variability in the clinical picture (Aho 1975). Stroke registers use the WHO definition: rapidly developing signs of focal or global disturbance of cerebral function lasting over 24 hours (unless interrupted by surgery or death), with no apparent nonvascular cause (Truelsen et al. 2003). The increasing availability of imaging techniques may have improved the detection of milder cerebrovascular disease cases in clinical settings but their use in population studies is very limited.

### 2.1.2.2 *Occurrence and secular changes*

Mortality from cerebrovascular disorders has decreased by 50% among middle-aged Finns during the past 20 years (Statistics Finland 2003a). Mortality from stroke has also declined substantially among men and women aged 75–84 years. In an international comparison, Finland is among the countries with middle-high mortality from stroke (Thom 1993; Sans et al. 1997; Sarti et al. 2000).

The incidence of stroke in the middle-aged Finnish population has also decreased (Sarti et al. 1994; Numminen et al. 1996; Tuomilehto et al. 1996; Sivenius et al. 2004), but markedly less than mortality. Incidence of stroke has decreased also in the elderly (Numminen et al. 1996). The 28-day case-fatality of stroke in Finland

has fallen from 1983 to 1992 (Immonen-Räihä et al. 1997). Results from the WHO MONICA Project in nine countries suggest that changes in stroke mortality from 1982 to 1995 among persons aged 35–65 years are principally attributable to changes in case-fatality rather than changes in event rates (Sarti et al. 2003). Thus, it is important to also obtain information about nonfatal events when assessing the burden of stroke in a community.

The number of in-patient days due to stroke increased during the 1980s and 1990s because of the aging of the population. In particular, hospital bed days due to stroke increased in women aged 75 years or over (Mähönen et al. 1994; Aromaa et al. 1999). In 1994, half of all hospital bed days for treatment of stroke were for persons aged 75 years or over, and 70% of these were for women (Salomaa et al. 1996c). Stroke has become a geriatric problem; both the relatively faster decline in stroke mortality compared with incidence, suggesting improved survival, and the increase in the elderly segment of the population have contributed to this. Thus, the observed declining trend in stroke incidence has not diminished the need for stroke care (Immonen-Räihä et al. 2003). Parallel results have been found also in Denmark (Thorvaldsen et al. 1999). Results from the United States suggest an increase in age-adjusted hospital admissions for stroke and also in self-reported stroke prevalence (Fang et al. 2001; Muntner et al. 2002).

More widespread and improved control of hypertension has played a major role in reducing cerebrovascular disease mortality. In Finland, two thirds of the fall in mortality from stroke in men and half in women can be explained by population changes in diastolic blood pressure (DBP), serum cholesterol concentration, and smoking (Vartiainen et al. 1995). In a study including nine countries, it appeared that variations in stroke trends between populations can be explained only in part by changes in classic cardiovascular risk factors. The association between risk factor trends and stroke trends were stronger for women than for men (Tolonen et al. 2002).

### 2.1.3 Heart failure

#### 2.1.3.1 *Definition and measurement*

Chronic heart failure is commonly defined as a pathophysiological state in which an abnormality of cardiac function is responsible for the failure of the heart to pump blood at a rate commensurate with the requirements of metabolizing tissues (Remme et al. 2001). The European Society of Cardiology diagnostic criteria require subjective symptoms at rest or during exercise, typically breathlessness, fatigue or ankle swelling, supported by objective evidence of cardiac dysfunction at rest. Response to treatment directed towards heart failure is considered

desirable. Echocardiography is recommended as the most practical tool to demonstrate cardiac dysfunction at rest (Remme et al. 2001).

Diagnosis of heart failure relies on clinical judgement based on history, physical examination, and appropriate investigations. ECG, chest x-ray, possibly natriuretic peptides, and echocardiography are the most important investigations. Several different systems have been used in large population studies to define heart failure: scores for clinical features determined from history and examination, chest radiography, general practice monitoring, and drug prescription data (McKee et al. 1971; Carlson et al. 1985; Marantz et al. 1988; Mosterd et al. 1999b; Davis et al. 2000). The accuracy of diagnosis by clinical means alone is often inadequate (Marantz et al. 1988; Remes et al. 1991). Echocardiography has been used in some more recent studies (McDonagh et al. 1997; Cowie et al. 1999; Di Bari et al. 1999; Davies et al. 2001). Different studies have used different levels of ejection fraction to define systolic dysfunction (Davis et al. 2000). The lack of universal agreement on a definition of heart failure (Denolin et al. 1983), as well as the lack of a golden standard to confirm the diagnosis, have both resulted in considerable heterogeneity in the diagnosis of heart failure in epidemiological studies (Cowie et al. 1997). This has made national and international comparisons of occurrence of heart failure difficult.

### *2.1.3.2 Occurrence and secular changes*

The most common causes of heart failure are CHD and hypertension. Heart failure is fairly uncommon in middle age, but increases rapidly after the age 65 (Kannel et al. 1991; Cowie et al. 1999). In eastern Finland, according to the Framingham criteria, the annual age-adjusted incidence of heart failure was 4.1 per 1000 among men and 1.6 per 1000 among women aged 45–74 years in the late 1980s (Remes et al. 1992). The prevalence of heart failure in Finnish urban population aged 75–86 years was 8% in 1990 (Kupari et al. 1997).

There are several reports suggesting an increase in mortality and morbidity from heart failure (Ghali et al. 1990; McMurray et al. 1993; Reitsma et al. 1996; Cowie et al. 1997; Haan et al. 1997; Rich 1997; Cleland et al. 1999; Haldeman et al. 1999). There are also contradictory results (Murdoch et al. 1998; Stewart et al. 2001). The number of people entitled to special refunds for heart failure medication costs has dropped sharply since the late 1970s in Finland (Data in files of the Social Insurance Institution, Finland 2002). Part of this change can be attributed to the reduced incidence of acute CHD events and more effective treatment of hypertension (Aromaa et al. 1999). However, some of the change is probably due to improvements in the diagnostics of heart failure. The better availability of echocardiography since the early 1990s has probably decreased the proportion of false positive heart failure diagnoses, which were fairly common in

primary health care in Finland in the 1980s (Remes et al. 1991). The number of patients with heart failure is expected to grow due to the aging of the population, improved survival after MI, and greater awareness and improved diagnostic techniques for the detection of heart failure (Eriksson 1995).

## 2.1.4 Hypertension

### 2.1.4.1 *Definition and measurement*

High BP is a well known risk factor for several common CVDs. It has been suggested that the relationship between BP and adverse health effects is continuous (Stamler et al. 1993; van den Hoogen et al. 2000). There has been debate, also recently, whether the relationship between BP and mortality is linear or whether there is a threshold below which there would be no reduction in the risk of diseases associated with the increase in BP (Alderman 2000; Port et al. 2000). A Finnish study showed that during a long follow-up, the relationship between systolic blood pressure (SBP) and mortality was flat up to 140 mmHg and increased after that in middle-aged men. Among men with other cardiovascular risk factors, however, the risk of death increased progressively and linearly with SBP (Strandberg et al. 2001b). Thus, the association between BP and CVDs is modified by other cardiovascular risk factors. These results support the concept of total risk assessment advocated in the current WHO-International Society of Hypertension guidelines for management of hypertension (Guidelines Subcommittee 1999). The definition of high BP has undergone many changes towards lower and lower threshold values during the last decades. The current Finnish Hypertension Society guidelines and the WHO-International Society of Hypertension guidelines define SBP < 120 mmHg and DBP < 80 to be optimal, SBP < 130 and DBP < 85 as normal, and SBP  $\geq$  140 and DBP  $\geq$  90 as hypertension (Guidelines Subcommittee 1999; Suomen Verenpaineyhdistys ry:n asettama työryhmä 2002).

The definition of hypertension in epidemiological studies usually relies on BP measurements and information on current use of antihypertensive medication. Casual BP measured with a classical mercury sphygmomanometer by the auscultatory method is commonly used (WHO 1962; Aromaa 1981; Aromaa 1982). Different BP limits have been used in epidemiological studies (WHO 1962; Aromaa 1981; Barker et al. 1998; Lloyd-Jones et al. 1999; Mosterd et al. 1999a; Vasan et al. 2002). A single casual measurement overestimates the prevalence of persistent high BP. However, suitably selected cut-off limits yield quite correct prevalence estimates: a cut-off of SBP  $\geq$  160 mmHg and DBP  $\geq$  95 mmHg resulted in an overestimate of only 2% (Aromaa 1982). The BP threshold levels for defining hypertension have decreased over time. Thus, the proportion of persons with hypertension who are receiving treatment and who have adequately controlled

BP has risen (Kastarinen et al. 1998), while at the same time the proportion of persons with elevated BP has decreased in the population (Laatikainen et al. 2003).

#### *2.1.4.2 Occurrence and secular changes*

The average level of BP in the Finnish population has decreased since the 1970s (Vartiainen et al. 2000; Laatikainen et al. 2003; Vartiainen et al. 2003). BP levels have decreased in all age groups, also among elderly (Aromaa et al. 2002). In an international comparison, the BP levels in Finland were high both in men and women in the 1980s (Wolf et al. 1997). The proportion of hypertensive persons who were unaware of their condition fell from 1982 to 1997, and at the same time, the proportion of hypertensive individuals with adequately controlled BP increased (Kastarinen et al. 1998). The numbers of persons receiving drug treatment for hypertension have steadily increased since the 1970s, mainly due to improved coverage as well as changing indications of treatment (Aromaa et al. 1999; Data in files of the Social Insurance Institution, Finland 2002). At the end of 2002, 8% of working aged and 30% of persons aged 65 or more were entitled to drug reimbursement for hypertension (Klaukka 2003).

## **2.2 Disability and burden imposed on society**

### **2.2.1 Definition and measurement of disability in epidemiological studies**

The terms disability, impairment, functional limitation, activity limitation, dysfunction, disablement, and handicap have been used in a variety of ways in the literature. The WHO International Classification of Functioning, Disability and Health (ICF), published in 2001, provides a comprehensive description of human functioning and its restrictions (World Health Organization 2001). The ICF organizes information into two parts with two components: 1) functioning and disability (the body functions and structures component and the activity and participation component), and 2) contextual factors (environmental factors and personal factors). Each component can be expressed in both positive and negative terms. Impairment is the negative term for the body functions and structures component, and activity limitations and participation restrictions for the activities and participation component. The term disability serves as an umbrella term for these three (impairment, activity limitation and participation restriction). Impairments are problems in body function or structure. Activity limitations are defined as difficulties an individual may have in executing activities, and participation restrictions are problems experienced in involvement in life situations. The former version of the WHO classification (World Health Organization 1980)

used the terms impairment, disability and handicap. The new terms (body functions and structures and activities and participation), which replace these extend the scope of the classification to positive experiences.

Theoretical frameworks have been proposed to describe the pathway from disease to disability (Nagi 1991). The conceptual framework of Nagi's model is organized around distinctions among the concepts of pathology, impairment, functional limitation, and disability (Nagi 1976; Nagi 1991). The conceptual scheme in the former WHO classification (World Health Organization 1980) is organized around four concepts: disease, impairment, disability, and handicap. ICF, the current WHO classification, differs substantially from the 1980 version in the depiction of the interrelations between functioning and disability. The new model is drawn to illustrate multiple interactions between body functions and structures, activities, participation, health condition, environmental factors, and personal factors. These interactions work in two directions e.g. not only from a disease to disability, but the presence of disability may modify the health condition.

In epidemiological studies, disability has been defined and measured in a variety of ways (Branch et al. 1987; Jette et al. 1988; Bild et al. 1993; Guralnik et al. 1993; Mäkelä et al. 1993). Disability is generally assessed through self-report or proxy report of difficulty or need for help in different tasks. Additionally, physical performance measures e.g. tests of standing balance, walking speed, or ability to rise from a chair, have been used (Guralnik et al. 1994).

Functional status has commonly been defined in terms of ability to perform basic activities of daily living (ADLs) and instrumental activities of daily living (IADLs). Katz et al. introduced the original ADL scale that included six personal care activities: eating, toileting, dressing, bathing, transferring from bed to chair, and continence (Katz et al. 1963; Katz et al. 1970). These questions were originally developed to assess the physical capabilities of older persons in long-term care or rehabilitation, but are now widely utilized in population surveys. Continence is typically not included in population estimates of ADL disability (Guralnik et al. 1993). These indicators identify the most severely disabled individuals. Walking a short distance, such as across a room, has been incorporated by some as an ADL measure (Branch et al. 1984). Different instruments have used a varying mix of these activities. Minor variations in the wording of items may produce different estimates of disability in similar populations (Wiener et al. 1990).

IADLs are tasks considered necessary for independent living in the community, but are more difficult and complex than the self-care domain represented by ADLs. Lawton and Brody first introduced a scale with several of these activities, including shopping, food preparation, housekeeping, doing laundry, using

transportation, taking medications, handling finances, and using the telephone (Lawton et al. 1969).

In addition to the ADLs and IADLs, a variety of other assessments of disability have been utilized. Rosow and Breslau and Nagi developed the most widely cited scales of more purely physical function (Rosow et al. 1966; Nagi 1976). Several studies of disability use three items from the Rosow-Breslau scale: walking up and down stairs to the second floor, walking a half-mile, and performing heavy housework. Items from the Organization for Economic Co-operation and Development (OECD) disability questionnaire have also commonly used. In the 1970's, the OECD aimed to develop indicators of long-term disability for general population surveys. The proposed items concentrate on physical functioning covering self-care, mobility, and communication (McWhinnie 1981). However, no one set of ADLs, IADLs, or higher order tasks most appropriate for defining disability exists (Guralnik et al. 1993). Prevalence estimates of disability vary according to the items used to define disability.

In this thesis the term disability is used as a general term to mean activity limitations indicating a need for help, and is measured by self-reports of difficulties in different tasks. The tasks included mainly measure physical functioning.

### 2.2.2 Secular changes in disability

There are a number of cross-sectional surveys in Finland concerning the health and functional capacity of elderly persons in one or two regions (Heikkinen et al. 1981; Haavisto et al. 1984; Heikkinen et al. 1984; Heikkinen et al. 1990; Heikkinen et al. 1992; Valvanne et al. 1992; Sairanen et al. 1993; Lehtonen et al. 1994; Sakari-Rantala et al. 1995; Niinistö et al. 1996; Winblad et al. 2001). Studies including information on health and the need for care of elderly Finns, representative of the whole country, have been interview or postal questionnaire surveys (Kalimo et al. 1982; Sauli et al. 1989; Kalimo et al. 1992; Tyrkkö 1996; Lahelma et al. 1997; Arinen et al. 1998; Noro et al. 2000; Sulander et al. 2001), except for the Mini-Finland Survey in 1978–1980 (Aromaa et al. 1989b) and the Health 2000 Survey (Aromaa et al. 2002).

Findings from studies on secular trends in health and functional capacity of elderly Finnish persons mainly suggest a slight decline in disability and the need for help among the elderly (Ruikka et al. 1984; Jylhä et al. 1992; Pohjolainen et al. 1997; Laukkanen et al. 1999; Pitkälä et al. 2001; Sulander et al. 2001; Aromaa et al. 2002; Malmberg et al. 2002; Martelin et al. 2002) although results vary between age group, gender, and the measure of disability. Contradictory results have been reported as well. In a study including a sample aged 60–89 years in Tampere in 1979 and 1989, there were only minor differences in functional ability between the



cohorts. Only in the youngest age group (60–69 years) did difficulties with certain ADL functions decline from 1979 to 1989 (Jylhä 1993). In two rural municipalities, Pyhäjärvi and Kärsämäki, in the district of Northern Ostrobothnia, no change in the prevalence rates of disability among persons aged 75 or over was observed from 1979 to 1989, nor to 1999 (Winblad 1993; Winblad et al. 2001). A decline in the functional status of community-living persons aged 75 or over was observed from 1978 to 1988 in a rural community of Kuusamo in northern Finland (Anttila 1991). The assessment of secular changes in functional capacity in Finland, based on these studies, is difficult because the study populations have usually been from one or two regions, and the methods and participation rates have varied. In addition, institutionalized persons are not always included in the surveys.

Most studies on secular trends in functional capacity of the elderly in different populations suggest that functional capacity has increased (Manton et al. 1997; Ostir et al. 1999; Ahacic et al. 2000; Waidmann et al. 2000; Manton et al. 2001; Freedman et al. 2002), but it has also been claimed that the observed secular changes are fluctuations rather than consistent trends (Crimmins et al. 1997).

### 2.2.3 Chronic morbidity and disability

In many developed countries mortality is decreasing, and percentages and absolute numbers of elderly individuals are increasing (World Population Ageing: 1950–2050 2001). The Finnish population is also becoming older. The number of individuals 65 years of age or more will increase by over 70%, meaning an increase of 580 000 persons, by 2030. Within this age group, the most rapidly growing segment is persons who are more than 80 years of age (Statistics Finland 2003b). The incidence of many chronic diseases, including CHD, and the prevalence of disability increase with increasing age (Guralnik et al. 1993; Andersen-Ranberg et al. 1999). The impact of the aging population on the future disability burden depends on the developments of chronic morbidity and functional ability of elderly individuals (Khaw 1999). The burden of a chronic disease on society depends on its prevalence in each age group, determined by its incidence and prognosis, the proportion and degree of disability due to it, and the age structure and size of the population. In many societies, the number of elderly is increasing at such a rate that despite a possible reduction of incidence and prevalence of chronic disorders, the number of ill persons may increase resulting in an increase in the need for care.

Health problems are the main cause of disability (Guralnik et al. 1996; Fried et al. 1997). Activity limitations are important determinants of quality of life and need for help. Disability is also a major risk factor for dependency and institutionalization (Fried et al. 1994). As the number of chronic conditions increases, disability rises rapidly (Verbrugge et al. 1989). The type of disease is also important



in determining disability. The impact of disease on disability is, however, modified by the individual's age, gender, social support, and other factors in the environment (Fried et al. 1997). Disability prevalence is higher in women than in men, especially at advanced age (Guralnik et al. 1993; Fried et al. 1997; Andersen-Ranberg et al. 1999), possibly arising from the greater longevity of females at any given level of functional impairment (Manton 1988; Strawbridge et al. 1992).

A number of chronic conditions associated with aging are consistently found to be strongly related to disability (Stewart et al. 1989; Verbrugge et al. 1989; Guralnik et al. 1996; Stuck et al. 1999). Different chronic conditions are likely to have a different impact on functional ability. There are only a few studies examining the degree to which particular chronic conditions contribute to disability and dependency (Stewart et al. 1989) and the proportion of disability in the population attributable to specific medical conditions (Mäkelä et al. 1993; Guccione et al. 1994). Both prevalence and disability impact of a condition are important determinants of the disability burden caused by it (Verbrugge et al. 1989).

#### *2.2.3.1 Cardiovascular diseases and disability*

In cross-sectional studies an association has been found between disability and CVDs (Lammi et al. 1989a), particularly CHD (Verbrugge et al. 1989; Pinsky et al. 1990; Ettinger et al. 1994; Guccione et al. 1994; Fried et al. 1999) and stroke (Jette et al. 1988; Verbrugge et al. 1989; Ettinger et al. 1994; Guccione et al. 1994; Fried et al. 1999). CVDs have also predicted future disability in longitudinal studies (Konu 1977; Harris et al. 1989; Keil et al. 1989; Lammi et al. 1989b; Lammi et al. 1990; Nickel et al. 1990; Boult et al. 1994). A recent prospective study showed that acute MI and congestive heart failure decrease physical functioning, and these negative consequences are not temporary (van Jaarsveld et al. 2001). Of stroke survivors, one third remained disabled (Hankey et al. 2002). It has been suggested that women with CVD are at higher risk for subsequent decrease in function, than are men (Chirikos et al. 1984; Nickel et al. 1990; van Jaarsveld et al. 2002).

Very few studies have examined the functional capacity of persons suffering from CVDs in a non-selected population (Pinsky et al. 1990; Ahto et al. 1998). Usually, the studies concern individuals selected by the severity of the disease (Nickel et al. 1990; van Jaarsveld et al. 2001). Research on the importance of specific CVDs in comparison with each other, and on CVDs as determinants of disability compared to other chronic conditions, has been scarce (Stewart et al. 1989; Guccione et al. 1994).

## 2.2.4 Coronary heart disease and disability burden

It is estimated that the burden caused by CVDs will increase during the coming decades (Sans et al. 1997; Beller 2001). Also in Finland, aging of the population may lead to a substantial increase in the number of patients with CHD, and the average age of the patients will markedly increase (Aromaa et al. 1999; Statistics Finland 2003b). The burden of CHD on society depends on the need for care and consequences of the disease, determined by incidence, prevalence, and severity. Mortality and incidence have recently changed due to changes in life style and treatment (Vartiainen et al. 1994b; Salomaa et al. 1996a; Salomaa et al. 2003).

To understand the current and future burden imposed by CHD, it is important to be aware of secular trends. Changes in both the prevalence of CHD and in the functional capacity of persons suffering from these diseases are important determinants of the disability burden. There are no population-based studies in Finland on secular trends in functional capacity among persons suffering from chronic CHD. It is not known how the functional ability of CHD patients has changed when CHD mortality has decreased, CHD morbidity has been postponed to older ages, and due to better treatment more CHD patients have survived (Abrahamsson et al. 1998; Rosamond et al. 1998; Salomaa et al. 1999; Tunstall-Pedoe et al. 2000).

## 2.2.5 Disability as a predictor of mortality

It is well known that disability is associated with increased risk of death. Several studies have found disability to be a strong predictor of mortality, both in the community-dwelling elderly and in those who have been institutionalized (Koyano et al. 1986; Reuben et al. 1992; Brock et al. 1994; Corti et al. 1994; Guralnik et al. 1994; Corti et al. 1996; Guralnik et al. 1996; Scott et al. 1997; Fried et al. 1998; Inouye et al. 1998; Ostbye et al. 1999; Ostir et al. 1999; Hirvensalo et al. 2000; Ramos et al. 2001). Physical disability was an independent predictor of CHD mortality in both older men and women, and for CHD incidence only in women (Corti et al. 1996). Functional restrictions of ADL prior to MI are important predictors of clinical severity and mortality in elderly MI patients in acute clinical settings (Brezinski et al. 1991; Vaccarino et al. 1997). However, knowledge on the impact of disability as a predictor of mortality and other complications in persons with CHD is based almost exclusively on study populations drawn from clinical settings or otherwise not representing general populations (Spertus et al. 2002). Cardiac rehabilitation improves physical functioning among CHD patients, also among the elderly (Ades 1999; Ades et al. 1999; Pasquali et al. 2001). In randomized trials, intervention programmes reducing disabilities have been shown to improve the prognosis of patients with acute MI (Kallio et al. 1979). It can also be assumed that similar interventions would improve the prognosis of people with CHD in the general population.

### **3 AIMS OF THE STUDY**

The general aim of the study was to examine the impact of CVDs as determinants of disability in elderly Finns. The specific aims of the study were to:

1. examine secular changes in the prevalence of CVDs in Finland over the past 20 years (I)
2. describe the functional capacity of persons suffering from specific CVDs, and to estimate the importance of these diseases as determinants of activity limitations and need for help in elderly Finns (II)
3. examine changes over time in the prevalence of disability and need for help in persons with and without CHD, and to analyze secular changes in the disability burden at population level due to changes in the prevalence of CHD and in the CHD-related disability (III)
4. assess the impact of disability on mortality in persons with and without CHD (IV)

## 4 MATERIALS AND METHODS

### 4.1 Health examination surveys

The studies in this thesis used data from three population-based cross-sectional health examination surveys (Table 1) undertaken in Finland from 1978 to 1980 (Mini-Finland Health Survey) (Lehtonen et al. 1986; Aromaa et al. 1989a; Aromaa et al. 1989b), in 1997 (FINRISK-97 Senior Survey)(Martelin et al. 1998), and from 2000 to 2001 (Health 2000 Survey) (Aromaa et al. 2002). Largely similar methods were used in these three surveys. One study (IV) was based on the Mini-Finland Health Survey (from 1978 to 1980), with mortality follow-up until the end of 1994.

**Table 1. Characteristics of the population-based cross-sectional health examination surveys.**

Name of survey	Survey period	Representativeness	Samples	Age range (years)	Sampling method
Mini-Finland Health Survey	1978–1980	Representative of the whole Finnish population of 30 years of age or more	8 000 (3 637 men and 4 363 women)	30–99	Two-stage sampling design
FINRISK-97 Senior Survey	1997	Two areas: North Karelia and the capital city region (Helsinki and Vantaa)	1 500 (500 men and 250 women in both areas)	65–74	Random population sample
Health 2000 Survey	2000–2001	Representative of the whole Finnish population of 30 years of age or more	8 028 (3 637 men and 4 391 women)	30–99	Two stage sampling design

#### 4.1.1 The Mini-Finland Health Survey

The Mini-Finland Health Survey comprised several phases. In the first phase nurses interviewed study subjects in their homes or the institutions in which they were living. The subjects were then invited to attend the second phase, a health examination. In the first part of the health examination (screening examination), self-administered health questionnaires were reviewed, interviews of symptoms performed, height, weight, and BP measured, ECG registered, and blood samples taken. Subjects with chronic disease histories, symptoms, or findings suggestive of cardiovascular, respiratory, or musculoskeletal diseases were asked to participate in the second part of the health examination, a clinical phase involving a standardized physical examination.

The screening procedure was effective: in a validation sample (N = 1 321) invited to participate in the second phase regardless of screening status, the sensitivity of

screening was 100% for AP, 100% for MI, 100% for heart failure, and 97% for any CVD.

#### 4.1.2 The FINRISK-97 Senior Survey

The FINRISK-97 Senior Survey belongs to a series of cross-sectional population surveys conducted every fifth year in Finland since 1972 (Vartiainen et al. 1995; Vartiainen et al. 1998). Earlier surveys covered only middle-aged individuals. In 1997, Finns 65–74 years of age were included in two areas of the FINRISK Survey. The FINRISK Senior Survey was carried out in North Karelia, an area in which cardiovascular morbidity has been high, and in Helsinki and Vantaa, the capital and a neighbouring city, in which morbidity has been intermediate i.e. at the national level (Joensuu 1989). The purpose of the FINRISK Senior Survey was to determine changes since the late 1970s by comparing findings with those from the Mini-Finland Survey.

The FINRISK-97 Senior Survey protocol was implemented via a one-phase field examination complemented by home visits to non-participants. A self-administered questionnaire was included in each letter of invitation. Completed questionnaires were reviewed at field examination sites. Trained nurses conducted interviews about health, previous diseases, functional ability and the need for help, following detailed written instructions and using a structured interview form. BP, height and weight were measured. Cognitive function was measured by a shortened form of the Mini Mental State Examination (MMSE) (Magaziner et al. 1987). In Helsinki and Vantaa resting ECG were recorded. Field examinations ended with standardized physical examinations by physicians. Nurses visited the homes of individuals who did not attend field examinations.

#### 4.1.3 The Health 2000 Survey

The Health 2000 Survey was a health interview and examination survey carried out in Finland from fall 2000 to spring 2001 (Aromaa et al. 2002). One of its aims was to determine changes in health, functional ability and the need for help from 1978–80. A two stage sampling design was used, and for the population aged 80 years and over the sampling probability was twice as high as among those aged under 80. First, a home interview was conducted. After one to six weeks the examinees received an invitation to attend a comprehensive health examination including questionnaires, measurements (e.g. BP and resting ECG) and a doctor's physical examination. Nurses visited the homes of individuals who did not attend field examinations.

**Table 2. Participation rates in the health surveys.**

	Men								Women							
	Sample	Inter-viewed at home		Health examined		Health examined at home		Sample	Inter-viewed at home		Health examined		Health examined at home			
		N	%	N	%	N	%		N	%	N	%	N	%		
Mini-Finland Survey																
45–64	1499	1448	96.6	1384	92.3	-	-	1704	1640	96.2	1573	92.3	-	-		
65–74	490	470	95.9	436	89.0	-	-	760	719	94.6	642	84.5	-	-		
75–99	201	193	96.0	159	79.1	-	-	447	424	94.9	307	68.7	-	-		
45–99	2190	2111	96.4	1979	90.4	-	-	2911	2783	95.6	2522	86.6	-	-		
FINRISK-97 Senior Survey																
65–74	1000	-	-	739	73.9	119	11.9	500	-	-	374	74.8	56	11.2		
Health 2000 Survey																
45–64	1575	1374	87.2	1301	82.6	37	2.3	1627	1485	91.3	1430	87.9	32	2.0		
65–74	422	378	89.6	345	81.8	22	5.2	571	497	87.0	461	80.7	25	4.4		
75–99	324	279	86.1	212	65.4	45	13.9	840	680	81.0	450	53.6	188	22.4		
45–99	2321	2031	87.5	1858	80.1	104	4.5	3038	2662	87.6	2341	77.1	245	8.1		

## 4.2 Study populations

Different sample constructions were used according to the purpose of each original study. The participation rates of the surveys were high – 90% of men and 87% of women participated in the health examination of the Mini-Finland Health Survey in 1978–1980. In the FINRISK-97 Senior survey, 86% of men and women participated in the field or home health examinations. In the Health 2000 Survey, 80% of men and 77% of women participated in the field health examination. However, the participation rates were lower in the oldest age group; 65% of men and 54% of women aged 75 years or more participated in the field health examination of the Health 2000 Survey. A substantial proportion of elderly non-participants were examined at home by nurses. The extent of the home examination was, however, more limited than the health examination proper (Table 2).

Study populations of original articles are shown in Table 3. Studies I and III were based on two cross-sectional national population surveys carried out 20 years

**Table 3. Study populations of original publications.**

Study	Surveys	Age range (years)	Participants
I	Mini-Finland Health Survey 1978–1980 and FINRISK-97 Senior Survey 1997	65–74	436 men and 642 women (Mini-Finland) 858 men and 430 women (FINRISK-97 Senior Survey)
II	FINRISK-97 Senior Survey 1997	65–74	858 men and 430 women
III	Mini-Finland Health Survey 1978–1980 and Health 2000 Survey 2000–2001	45–99	1 975 men and 2 521 women (Mini-Finland) 1 850 men and 2 334 women (Health 2000)
IV	Mini-Finland Health Survey 1978–1980 with mortality follow-up until the end of 1994	45–99	1 979 men and 2 522 women were followed-up; 897 men and 846 women died during follow-up

apart, study II was an association study in a cross-sectional cohort, and study IV was a prospective cohort study.

### 4.3 Study variables and definitions

#### 4.3.1 Coronary heart disease

Definition of CHD was based on different sources according to the purposes of each original study. Answers to similarly worded standard questions relating to known diseases were available from the largest numbers of participants in all three surveys. For studies I, II and III, answers to the question “Has a doctor ever diagnosed that you suffer from one of the following diseases 1) angina pectoris, 2) myocardial infarction?” were used. CHD was defined as AP or history of MI.

In studies I, II and IV, clinical diagnoses of AP and MI were used. Trained physicians followed detailed written instructions, and applied uniform diagnostic criteria in accordance with good clinical practice in standardized physical examinations. The diagnostic criteria used in the surveys were similar. The examining physician critically assessed the disease and symptom history, and available documents and performed a structured physical examination. Diagnostic assessments were recorded on structured forms. AP was defined as typical chest pain brought on by exertion and relieved by nitroglycerine or by rest. MI was defined as a positive history in the medical records, old MI on ECG, or typical self-reported history of MI treated in hospital. Any CHD was defined as AP, MI, history of coronary by-pass surgery, or angioplasty.

#### *4.3.1.1 Mortality from coronary heart disease*

Data on causes of death obtained from Statistics Finland were linked to the study data by personal identification numbers. Coverage of the mortality register based on death certificates was almost complete, including emigrants who died abroad. The codes 4100A–4149X of ICD-9 (International Classification of Diseases, ninth revision) were used for CHD as the cause of death (study IV).

#### *4.3.2 Other cardiovascular diseases*

In studies I and II other CVDs were also considered. Both self-reported and clinical diagnoses were used.

##### *4.3.2.1 Self-reported other cardiovascular conditions*

Chronic morbidity was assessed by the question: “Has a doctor ever diagnosed that you suffer from the following diseases: 1) hypertension or high blood pressure, 2) heart failure, 3) stroke or 4) intermittent claudication?”

##### *4.3.2.2 Clinical diagnoses of other cardiovascular conditions*

Hypertension was diagnosed if an individual took blood-pressure medication or had SBP of 160 mmHg or above and DBP of 95 mmHg or above. This classification of hypertension, which is not exactly the same as the WHO recommendation, was used in order to avoid overestimation of the prevalence of persistent high BP, and to be comparable with the definition used in the Mini-Finland Health Survey. In study IV, a four-category classification was used (see later). Heart failure was defined as congestive heart failure according to medical records or definite self-reported history of diagnosed congestive heart failure. Cerebrovascular disease was defined as positive history of cerebrovascular attack in the medical records or definite self-reported history of an attack diagnosed by a doctor. Intermittent claudication was defined as positive history of intermittent claudication in the medical records, previous bypass surgery, angioplasty or other operation for peripheral vascular disease, or definite self-reported history of intermittent claudication.

##### *4.3.2.3 Any cardiovascular disease, any cardiovascular disease except hypertension and any heart disease*

In analyses concerning self-reported history of diseases and clinical diagnoses, any CVD means MI, AP, hypertension, heart failure, cerebrovascular disease, or intermittent claudication. Any CVD except hypertension means any of these diagnoses except hypertension alone. Heart disease means MI, AP, or heart failure.



### 4.3.3 ECG findings

ECG data was used in study I. ECG findings were coded using the Minnesota code. Probable old MI included Minnesota codes 1.1 or 1.2 together with 5.1–2. Other ischaemic ECG changes indicating possible CHD included Minnesota codes 1.2 without 5.1–2, 1.3, 4.1–3, 5.1–2, 6.1–2, 7.1–2, 7.4, or 8.3 (I) (Reunanen et al. 1983).

### 4.3.4 Other chronic diseases

The health interview also elicited information on other chronic diseases. In the analysis, these were combined into five larger groups: diabetes, respiratory diseases, musculoskeletal disorders, other somatic diseases, and mental disorders. In the analysis restricted to those subjects who attended the clinical examination, the diagnoses of other chronic diseases were based on clinical diagnoses made by physicians (II).

### 4.3.5 Disability

The health interviews and health questionnaires elicited information on whether the person could perform certain activities without difficulty, with some difficulties, with marked difficulty, or not at all: 1) moving about in the house, 2) getting in and out of bed, 3) dressing and undressing, 4) carrying a shopping bag of 5 kg, 5) walking 400 m (500 m without rest in study III), 6) climbing a flight of stairs (without rest in study III), 7) managing grocery shopping, 8) clipping one's toenails, 9) reading a newspaper, 10) performing heavy housework such as cleaning, and 11) travelling on public transport. This series of questions was modified from the classification of functional capacity initially introduced by Katz et al. and Lawton et al. (Katz et al. 1963; Lawton et al. 1969; Katz et al. 1970) by also including the OECD disability questionnaire (McWhinnie 1981), and it has been used in a national survey to estimate the occurrence of disability (Aromaa et al. 1989b; Mäkelä et al. 1993).

For the purposes of each original report, definitions of disability based on the above mentioned questions were used. For study II, disability was defined as being unable to perform without help at least one of tasks 1–11. In study IV, disability was defined as either being unable to perform without help or having marked difficulty in performing at least one of tasks 1–11. This broader definition was used in order to obtain enough observations in every category at baseline and during mortality follow-up. For study III, disability was defined as either being unable to perform without help or having marked difficulty in performing at least

one of tasks 1–7. The availability of comparable information limited the use of tasks 8–11 in this substudy. Persons who were almost or totally blind were also considered to be disabled.(Aromaa et al. 1989b; Mäkelä et al. 1993)

#### 4.3.6 Cognitive impairment

Cognitive impairment was included in the analyses of study II. The shortened form of the MMSE (Folstein et al. 1975; Magaziner et al. 1987) included 9 of the 19 original MMSE questions. A score of less than 14 (maximum 19) on the shortened MMSE, corresponding approximately to the lowest quintile in the age group under consideration (65–74 years), was taken to indicate cognitive impairment.

#### 4.3.7 Obesity

Height and weight were measured and body mass index (BMI)  $\text{weight/height}^2$ ,  $\text{kg/m}^2$  calculated. A body mass index (BMI) of 30 or more was defined as obesity (study II). A four-category classification was used in study IV.

#### 4.3.8 Blood pressure

Casual BP was registered in the sitting position after a 5-min rest by the auscultatory method. The subjects were classified into four hypertension classes based on the levels of SBP and DBP and the possible use of antihypertensive medication (Aromaa 1981). Persons with  $\text{SBP} \geq 170$  mmHg and  $\text{DBP} \geq 100$  mmHg and those using antihypertensive drugs were considered to be definitely hypertensive. Of the remaining study population, those with  $\text{SBP} \geq 160$  mmHg and  $\text{DBP} \geq 95$  mmHg were considered to have mild hypertension, and those with  $\text{SBP} < 140$  mmHg and  $\text{DBP} < 90$  mmHg were considered to be normotensive. All other persons were considered to have borderline hypertension (study IV).

#### 4.3.9 Other variables

Serum samples were taken and cholesterol concentration determined by an auto-analyzer modification of the Liebermann-Burchard reaction (in the Mini-Finland Health Survey) (Carr et al. 1956). Quintiles of total cholesterol were used in the analyses. The health interview provided information on smoking habits. The subjects were classified according to smoking 1) as those who had never smoked, 2) former smokers, 3) current smokers of cigars or pipes only or  $< 20$  cigarettes per day, and 4) current smokers of  $\geq 20$  cigarettes per day (study IV).

## **4.4 Statistical methods**

### **4.4.1 Means and prevalences**

Age-adjusted means of baseline risk factors were calculated using a linear model (Lee 1981). Prevalences adjusted for age were estimated using a logistic model (I and III) (Breslow et al. 1987). Statistical significance of differences between prevalences was tested using the likelihood ratio test based on the model. Estimation of age-adjusted prevalences of disability in persons with and without CHD in the 1978–1980 and the 2000–2001 surveys was performed by including age (years), CHD, survey and an interaction term between CHD-status and survey in the model (III).

### **4.4.2 Mortality**

The Cox proportional hazards model was used to estimate age-adjusted and multivariate adjusted relative risks (RR) for all-cause and CHD mortality among disabled and non-disabled persons with and without CHD (Cox 1972). Follow-up time was considered as the time from the Mini-Finland baseline examination date (1978–1980) to death, date of withdrawal, or the end of 1994, whichever came first. In order to obtain age-adjusted RRs for persons in various subgroups at baseline age, CHD, disability, and an interaction term between baseline CHD-status and disability were included in the model.

### **4.4.3 Impact of cardiovascular diseases and other chronic diseases on disability**

The relationship between disability and its determinants was assessed using the logistic model. Odds ratios (OR) with 95% confidence interval (95% CI) obtained with the model were calculated to assess the association between disability and various CVDs and other specific chronic diseases (II, III). In study III, an interaction term between CHD-status and survey was included in the model in order to assess the importance of CHD as a determinant of disability in the 1978–1980 and 2000–2001 surveys.

To understand the impact of each chronic condition in terms of its prevalence as well as its odds of disability, the proportion of disability attributable to each condition was computed as an adjusted attributable fraction (Greenland 1984) (study II).

#### 4.4.4 Assessment of the impact of the changes in coronary heart disease on disability

In study III, attributable fractions were estimated by the method of Greenland and Drescher (Greenland et al. 1993) on cohort studies, and a Stata macro called aflogit by Tony Brady (PHLS Statistics Unit, London).

In order to assess the proportion of change in the prevalence of disability explained by changes in the prevalence of CHD and in CHD-related disability, we used the following formula:

$$(PD_{CHD2000} - PD_{CHD1980}) / (PD_{2000} - PD_{1980}) \times 100$$

where

$PD_{CHD1980} = AF_{1980} \times PD_{1980}$  is the prevalence of disability due to CHD in the population in 1978–1980,

$PD_{CHD2000} = AF_{2000} \times PD_{2000}$  is the prevalence of disability due to CHD in the population in 2000–2001,

$AF_{1980}$  is the attributable fraction for CHD in 1978–1980,

$AF_{2000}$  is the attributable fraction for CHD in 2000–2001,

$PD_{1980}$  is the age-adjusted prevalence of disability in the population in 1978–1980,

and

$PD_{2000}$  is the age-adjusted prevalence of disability in the population in 2000–2001.

#### 4.4.5 Statistical software

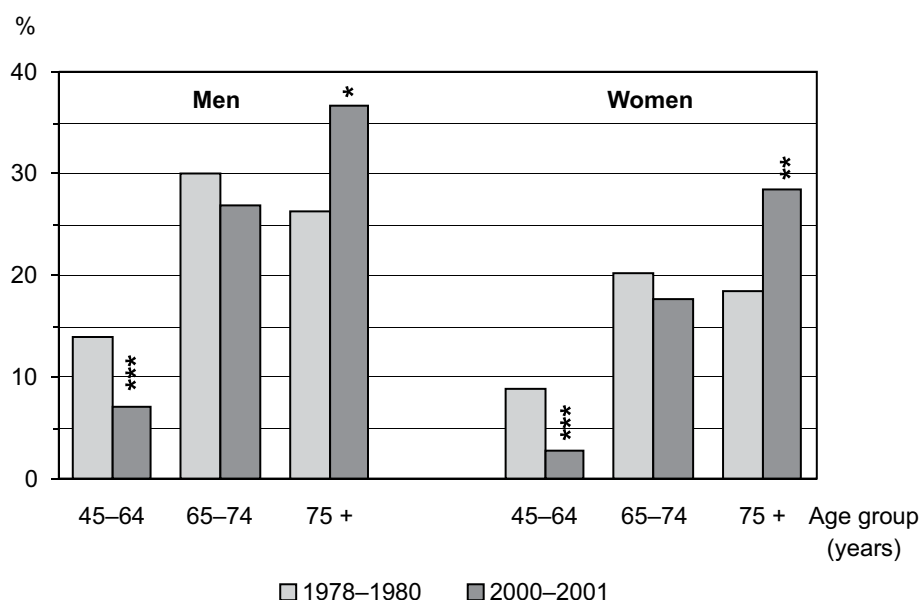
Statistical analyses were carried out with SAS, Release 6.12 (SAS Institute Inc., Cary, NC, USA). STATA, Release 7.0 (StataCorp., College Station, TX, USA) and the aflogit Stata macro (by Tony Brady, PHLS Statistics Unit, London) were used to calculate attributable fractions (in study III).

## 5 RESULTS

### 5.1 Secular changes in the prevalence of cardiovascular diseases

The prevalence of CHD based on health interview was lower in men and women aged 45 to 64 years in the 2000–2001 survey than in the 1978–1980 survey, but in the age group 65–74 no significant difference was observed. In those aged 75 years or more the prevalence of CHD was higher in the 2000–2001 survey than in the 1978–1980 survey (Figure 1; study III, Table 1). Results of study I, concerning prevalence of CHD among persons aged 65–74 years based on answers to structured disease questions, are in line with the results of study III. (Figure 2; Study I, Table 3).

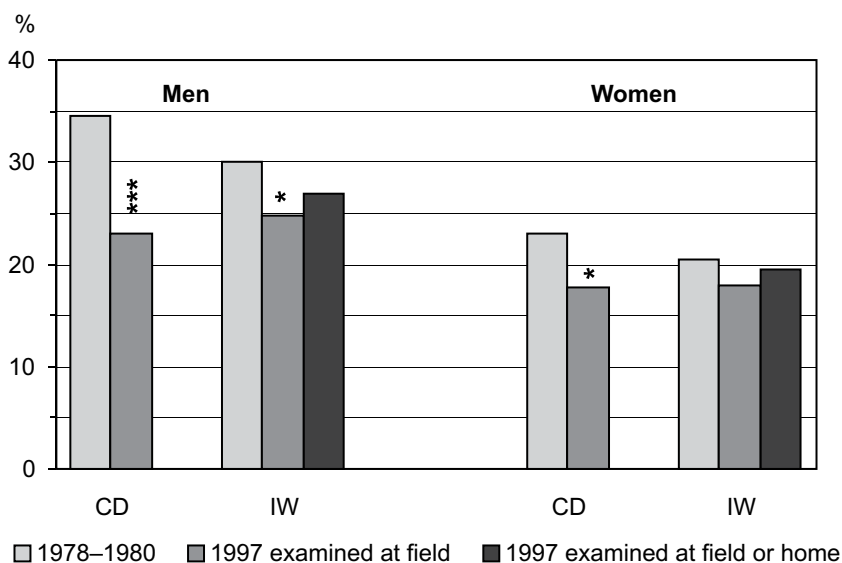
**Figure 1. Age-adjusted prevalence of CHD in Finland in 1978–1980 and 2000–2001.**



\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Results based on clinical diagnoses suggest that the prevalence of clinically diagnosed AP and of any manifestation of CHD were significantly lower in the 1997 survey than in the 1978–1980 survey in men and women aged 65–74 years.

**Figure 2. Age-adjusted prevalence of CHD among persons aged 65–74 years according to clinical diagnoses by field physicians and answers to structured disease questions.**



CD = clinical diagnoses

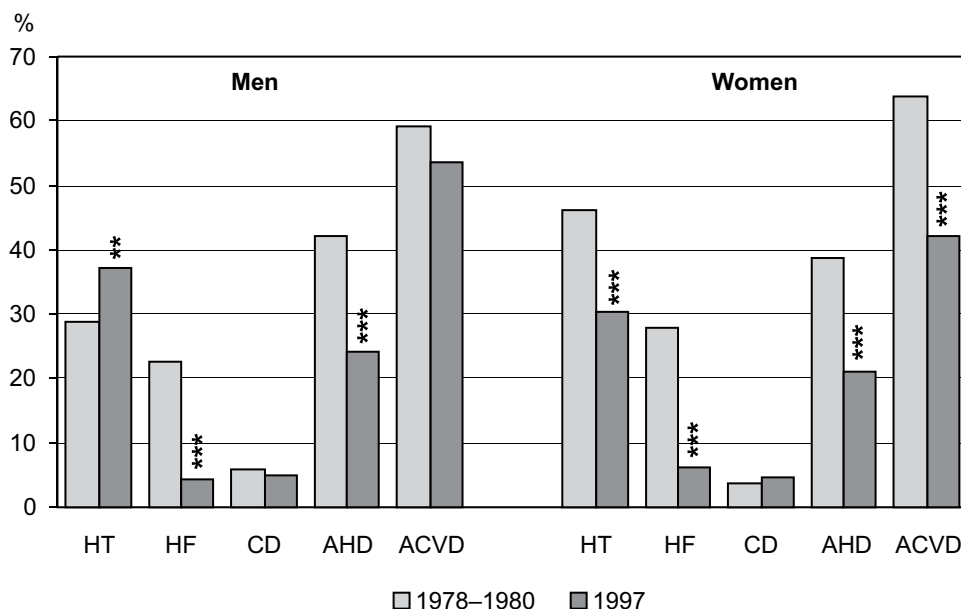
IW = interview (answers to structured disease questions)

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

No significant difference was observed in relation to previous MI. In resting ECGs the prevalence of large Q-waves, indicating previous MI, was significantly lower in men in the 1997 survey than in the 1978–1980 survey, whereas no corresponding decline was observed in women. The prevalence of any ischaemic ECG change, indicating possible CHD, was significantly lower in the 1997 survey than in the 1978–1980 survey in both genders (study I, Table 2).

The proportion of persons using antihypertensive drugs or having SBP of 160 mmHg or above and a DBP of 95 mmHg or above was markedly higher in men and lower in women in the 1997 survey than in the 1978–1980 survey (Figure 3; study I, Table 2). The increase in men was probably due to the increased use of antihypertensive medications. In the late 1970s, 17% of men and 33% of women used antihypertensives, whereas in the 1997 survey the corresponding proportion was 29% in men and 27% in women. In both genders the prevalence of clinically diagnosed heart failure had declined substantially. No significant change was observed in the prevalence of cerebrovascular disease (Figure 3; study I, Table 2).

**Figure 3. Age-adjusted prevalence of different CVDs in men and women aged 65–74 years according to clinical diagnoses by field physicians.**



HT = Hypertension, HF = Heart failure, CD = Cerebrovascular disease, AHD = Any heart disease, ACVD = Any cardiovascular disease

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

The prevalence of any CVD was significantly lower in women aged 65–74 years in the 1997 survey than in the 1978–1980 survey. The corresponding reduction in men was not statistically significant. The prevalence of any CVD except hypertension and of heart diseases were significantly lower in 1997 than in 1978–1980 in both genders (Figure 3; study I, Tables 2 and 3).

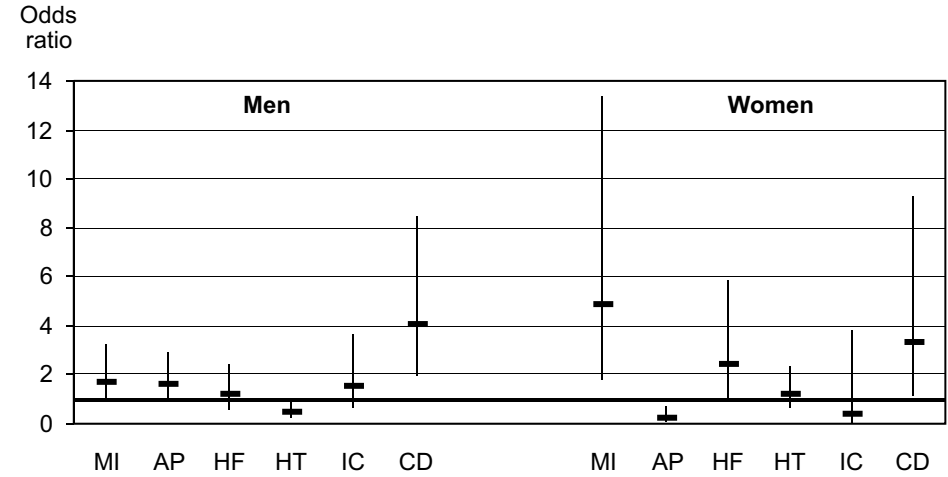
## 5.2 Cardiovascular diseases as determinants of disability

In 1997, 10% of men aged 65–74 years and 16% of women in this age group were disabled according to the definition used (study II, Table 1). Disability was over four times as common in the population examined at home than examined in the field. The prevalence of disability was particularly high among men and women suffering from cerebrovascular disorders (disability prevalence in men 31%, in women 44%) and mental disorders (men 40%, women 42%). Disability was common also among women with previous MI (46%) or suffering from heart failure (37%) (study II, Table 2).

Each CVD, except hypertension, was significantly associated with disability in men after adjustment for age. In age-adjusted analyses on women, MI, heart failure, hypertension, and cerebrovascular diseases were associated with disability. After adjustment for comorbidity, only cerebrovascular diseases (OR = 4.1, 95% CI = 1.9–8.5) were significantly associated with disability in men, while in women MI (OR = 4.9, 95% CI = 1.8–13.4), heart failure (OR = 2.5, 95% CI = 1.04–5.8), and cerebrovascular disease (OR = 3.3, 95% CI = 1.2–9.3) remained significant determinants of disability (Figure 4; study II, Table 4). In the analyses based on the clinical diagnoses obtained in the field examination, intermittent claudication also was a significant determinant of disability in men. The ORs obtained from these analyses were somewhat higher but essentially similar to those obtained from the analyses based on health interview data.

Of other chronic conditions, mental disorders were the most strongly associated with disability in both genders (OR = 7.1, 95% CI = 3.6–14.0 for men and OR = 4.7, 95% CI = 2.2–9.7 for women). Other determinants of disability, after adjustment for comorbidity, included diabetes, impaired cognition, and obesity in men, whereas only mental disorders were a significant determinant of disability in women (study II, Table 3).

**Figure 4. Cardiovascular diseases as determinants of disability among Finns aged 65–74 years (multivariate adjusted odds ratios).**



MI = Myocardial infarction, AP = Angina pectoris, HF = Heart failure, HT = Hypertension, IC = Intermittent claudication, CD = Cerebrovascular disease



To identify the public health impact of each determinant of disability in the age group covered by study II (65–74 years), the proportion of disability attributable to each condition was estimated. After adjustment for comorbidity, the population attributable fraction for any CVD, excluding hypertension alone, was 24% in women and 33% in men. Mental disorders, cognitive impairment, and obesity were the other important contributors to disability, with attributable fractions of around 20%. Of the CVDs, cerebrovascular disease (16%), MI (14%), and AP (13%) in men, and MI (20%), heart failure (18%), and cerebrovascular disease (11%) in women, had the highest attributable fractions (study II, Table 5).

### **5.3 Secular changes in CHD-related disability burden in Finland from 1978–1980 to 2000–2001**

#### **5.3.1 Prevalence of disability**

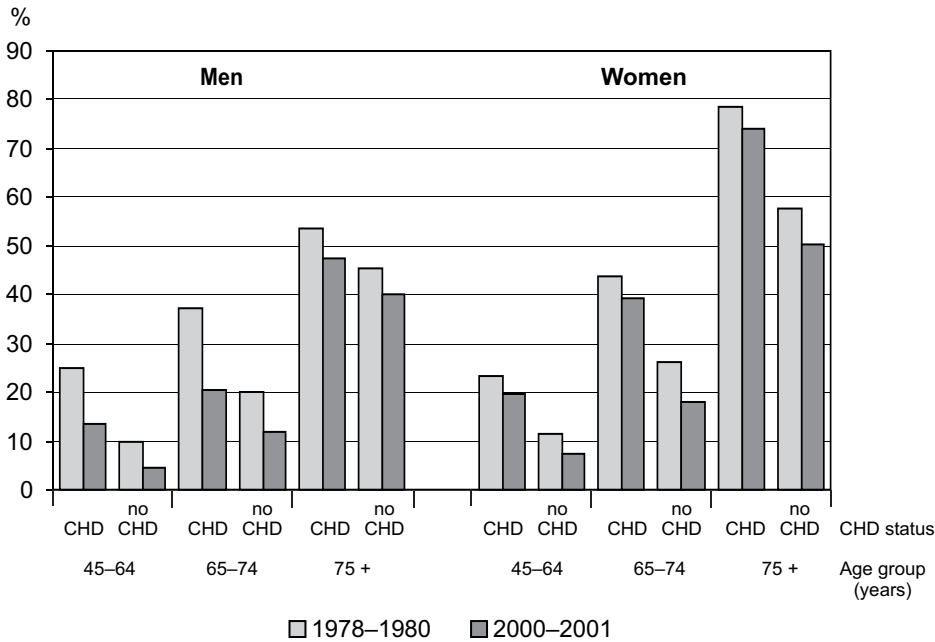
In both genders the prevalence of disability had significantly declined from the 1978–1980 survey to the 2000–2001 survey until the age of 75 years. The decrease was not statistically significant in the oldest age group (study III, Table 1).

In the 65–74 years age group, 37% of men and 44% of women with CHD were disabled in 1978–1980, whereas 20% of men and 39% of women were disabled in 2000–2001, according to the definition of disability used. In men, regardless of CHD status, the prevalence of disability had decreased significantly in the 45–64 and 65–74 age groups. The decrease was smaller and not statistically significant in the 75 or over age group. The decreases in the prevalence of disability were not statistically significant in women with CHD. Prevalence of disability was significantly lower in the 2000–2001 survey than in the 1978–1980 survey in the 45–64 and 65–74 age groups in women without CHD (Figure 5; Study III, Table 4).

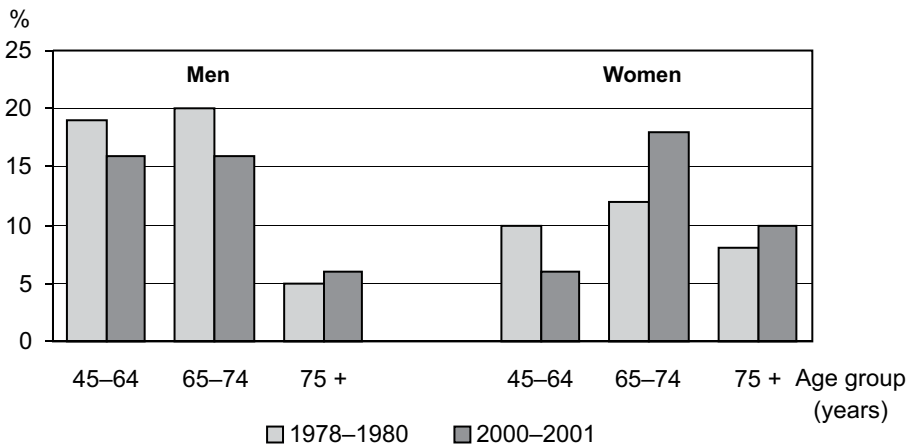
#### **5.3.2 Contribution of coronary heart disease to disability**

In men aged 45–64 and 65–74 years, 19–20% of disability was attributable to CHD in the 1978–1980 survey, and 16% in the 2000–2001 survey. In women the corresponding numbers were 10% in the 45–64 age group and 12% in the 65–74 age group in the 1978–1980 survey and 6% and 18% in the 2000–2001 survey. In the oldest age group of 75 years or over, 5% of disability in 1978–1980 and 6% in 2000–2001 was attributable to CHD in men. In women, the corresponding numbers were 8% and 10%. (Figure 6; study III, Table 3)

**Figure 5. Prevalence of disability in men and women with and without CHD in 1978–1980 and 2000–2001.**



**Figure 6. Percentage of disability attributable to CHD.**



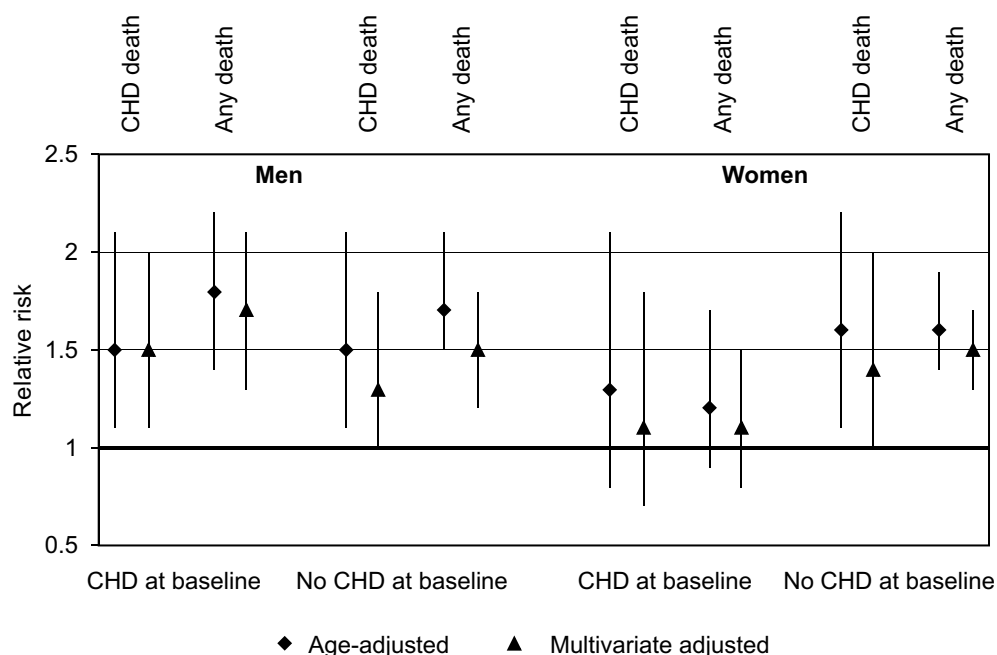
### 5.3.3 Contribution of coronary heart disease to the decline in disability from 1978–1980 to 2000–2001

The decrease in the prevalence of CHD together with the decrease in disability due to CHD explained a fifth of the whole decrease in disability in Finnish men aged 45–64 years during the past 20 years. In men aged 65–74 years, these two factors explained a fourth of the decrease in the disability. Among women aged 45–64 years, the contribution of CHD was estimated to be 17%. Among older men and women, CHD did not contribute to the functional ability changes at the population level (study III, Figure 1).

## 5.4 Disability as a predictor of mortality in persons with and without coronary heart disease

Disability in men increased the risk of death from CHD and all-causes regardless of CHD status at baseline, even after adjustment for potential cardiovascular risk factors (Study IV, Table 2). In women free of CHD at baseline, disability was related to increased total and CHD mortality, but no significant association was observed in women with baseline CHD (Figure 7; study IV, Table 2).

**Figure 7. Relative risk of death (with 95% confidence intervals) associated with disability in men and women according to CHD status at baseline.**



In comparison to persons with neither CHD nor disability, the multivariate adjusted RR of CHD mortality was 4.4 (95% CI = 3.3–5.9) in disabled men with CHD at baseline and 2.5 (95% CI = 1.8–3.6) in the corresponding group of women. CHD at baseline increased CHD mortality about 3-fold both in men with and without disability. In women the corresponding RR associated with CHD at baseline was about 2 regardless of disability status (Table 4).

**Table 4. Relative risks (RR) of death with 95% confidence intervals (CI) from coronary heart disease (CHD) and all-causes according to disability and CHD at baseline.**

	Subjects without CHD			Subjects with CHD			
	No disability		Disability	No disability		Disability	
	RR		RR CI	RR	CI	RR	CI
<b>Men</b>							
CHD mortality	1.0 (Referent)		1.3 1.0, 1.8	3.0	2.2, 4.1	4.4	3.3, 5.9
All-cause mortality	1.0 (Referent)		1.5 1.2, 1.8	1.7	1.4, 2.1	2.9	2.4, 3.5
<b>Women</b>							
CHD mortality	1.0 (Referent)		1.4 1.0, 2.0	2.2	1.4, 3.7	2.5	1.8, 3.6
All-cause mortality	1.0 (Referent)		1.5 1.3, 1.7	1.3	1.0, 1.7	1.4	1.2, 1.8

Cox proportional hazards model included age (years), CHD-status, disability, and the interaction term between CHD-status and disability, body mass index (<20, 20–24.99, 25–29.99, 30–34.99, ≥35), hypertension (4 classes), total cholesterol (quintiles), smoking status (never, past, and current smoking of 1 to 19, and ≥20 cigarettes per day), and diabetes.

The impact of disability on mortality was examined in different age groups. Disability was independently related to increased CHD and total mortality in men with baseline CHD after adjustment for potential cardiovascular risk factors, except in the oldest age group (75 years or over). In women with CHD at baseline, disability was not significantly associated with mortality from CHD or all-causes. In men free of baseline CHD, disability was a statistically significant predictor of mortality from all-causes in the 45–64 and 65–74 age groups, and from CHD in the 65–74 age group. In women free of baseline CHD, disability predicted excess all-cause mortality in all age groups and CHD mortality among those aged 45–64 years (study IV, Table 3).

## 6 DISCUSSION

### 6.1 Population

The validity of our results on secular trends depends first on the representativeness and comparability of the study samples, and second, on the comparability of the information on chronic morbidity and disability. In the 1978–1980 and the 2000–2001 surveys the samples were representative of the entire adult population of Finland. In the 1997 survey the sample was from two regions, in which morbidity from CVD has been high and moderate (Joensuu 1989; Aromaa et al. 1999). Our results in study I relate to all subjects aged 65–74 years in the 1978–1980 and 1997 surveys. Separate analyses were undertaken in which the 1997 survey results were compared with those in the corresponding geographical regions in the 1978–1980 survey. Results of these subsample comparisons and the consequent conclusions were no different from those of the larger-scale comparisons (data not shown).

Participation rates in all surveys were high. Still, participation rates were higher in the 1978–1980 survey than in later surveys, reflecting a general trend of decreasing participation in many countries. Since non-participation is selective with regard to disability, resulting in underestimation of the most severe disability, the decline in participation may have led to an underestimation of the prevalence of both disability and severe CVD in the later surveys. The overall decline in the prevalence of disability from 1978–1980 to 2000–2001 was, however, equally pronounced when we analyzed data based on home health interviews, for which information was available for 90% of the sample in 2000–2001 (Aromaa et al. 2002). Comparisons were also made with the Mini-Finland Health Survey (1978–1980) health examination data and the Health 2000 Survey (2000–2001) field and home health examination data (data not shown). These comparisons did not alter the basic conclusions drawn from the results concerning field health examinations of the two surveys. These analyses confirm the results suggesting that functional capacity of persons aged 75 years or more has not increased over the past 20 years. Depending on the purposes of each substudy, different groups of participants were chosen for the analyses. Careful attention was paid to the comparability of the results because the subpopulations included in the analyses influence on the results.

High participation rates, inclusion of institutionalized persons, and home examinations conducted for persons who could not attend the field examination were particular strengths of study II. In many previous studies subjects have been lost if they were unable to attend the examination due to medical conditions causing functional limitations (Jette et al. 1988; Verbrugge et al. 1989; Guccione et al. 1994). Such functional ability and health-related selection obviously tends to

bias the observed association between disease and disability (Hoeymans et al. 1998). Selection bias of CHD patients according to the severity of the disease, which may occur in studies based on a clinical series (Brezinski et al. 1991), was avoided in studies II (determinants of disability) and IV (disability as a predictor of mortality among persons with and without CHD) due to the use of random population samples.

## **6.2 Methods**

The validity of our findings also depended on the validity and comparability of the measurements of disability and chronic morbidity. In the studies, self-reported chronic diseases, clinical diagnoses, or if possible both, were used. The agreement between health interview and health examination is substantial in assessing CVD (Heliövaara et al. 1993). Among the participants in the field examination of the FINRISK-97 Senior Survey, the validity of self-reported CVD was assessed by comparing the self-reported diseases with physician-assessed clinical diagnoses. Kappa values indicating the agreement between diagnoses from the health interview and the clinical examination varied between 0.62 and 0.80, except for heart failure in men (0.45).

Similarly worded standard questions relating to known diseases were used in the surveys. Although the questions were similar, awareness of the subjects regarding diseases diagnosed by their physicians could have changed. It might be assumed that at the time of the later surveys individuals had used more health care and were better informed regarding their conditions than individuals 20 years previously. This could have resulted in an increased prevalence of reported CVDs and in a reduction of unreported CVD-cases in the latter surveys. On the other hand, more accurate diagnostics of some conditions may have decreased the number of false positive disease cases (e.g. diagnostics of heart failure).

Clinical diagnoses were also used, if possible. Although similar diagnostic criteria were used in the surveys, variations in clinical judgement can have occurred. Even if the same physicians had performed the physical examinations 20 years apart, diagnostic practices could have changed. Despite these possible sources of error it is plausible that diagnostic practices in relation to CVD were fairly similar in the different surveys. The credence that can be attached to the results in study I is increased by the fact that both the questionnaire method and the clinical examination method revealed almost identical changes in prevalences of CVD. The resting ECG findings provided additional objective evidence in relation to the results concerning CHD prevalence obtained on the basis of self-reporting and physical examination.

Disability was measured using similar structured questions in the surveys. The list of functional limitations has been successfully used in a national survey to estimate the occurrence of disability (Aromaa et al. 1989b). Most of the functional limitations were related to rather basic ADL and IADL activities, probably not much influenced by environmental changes during the past 20 years. The definition of disability (IV) has been compared to physician-assessment of disability and the need for help, kappa = 0.51 (Mäkelä et al. 1993).

Many different instruments have been used in studies of disability indicating that there is no consensus of the best instruments for measuring disability. In this study, the measures of disability were chosen in order to represent general and not only CHD-specific disability at the population level. This was the main reason for not using the NYHA-classification. However, some items from the list of functional limitations (e.g. walking 500 m without rest, climbing a flight of stairs without rest, and carrying a 5 kg shopping bag) are useful in assessing disability due to CVDs. The same measure of disability was used both for middle-aged and elderly persons. This prevented the use of more severe disability measures, yielding extremely low prevalences among middle-aged persons. It would be useful to examine secular changes in different degrees of disability. Due to practical limitations it was not possible to include many different measures of disability in these studies.

## **6.3 Prevalence of cardiovascular diseases (studies I and III)**

### **6.3.1 Coronary heart disease**

The prevalence of self-reported CHD in men and women aged 45–64 years had declined significantly during the past 20 years. In women and men aged 65–74 years no significant decline occurred in the prevalence of self-reported CHD, but a significant decline was seen in the prevalence of ischaemic ECG findings. The decreased prevalence of ECG Q-wave changes in men suggests that the most serious forms of CHD had also decreased. At the age 75 or over, the prevalence of self-reported CHD increased significantly in both genders.

Previous studies on time trends in the occurrence of CHD in Finland concern mainly CHD mortality and incidence of acute CHD events. Our results on CHD prevalence are in line with the decreasing trend in CHD mortality and incidence of acute CHD events (Salomaa et al. 1996a; Salomaa et al. 2003). According to a Finnish questionnaire survey, the prevalence of self-reported CHD has declined

among men and women aged 45–64 years (Puska et al. 1983; Piha et al. 1986; Berg et al. 1990; Helakorpi et al. 1998; Helakorpi et al. 2002). Reports on time trends among the elderly have been inconsistent; prevalence of CHD has declined slightly, remained stable (Kivelä et al. 1986; Uutela et al. 1999; Sulander et al. 2001), or even increased (Kalimo et al. 1992) among persons aged 65–74 years depending on the time period considered, definition of CHD, and gender. A study from the municipality of Lieto, in southwestern Finland, suggests that the prevalence of CHD decreased during the 1990s among persons aged 64–71 years (Hartikainen et al. 2003). The age-adjusted prevalence of drug reimbursements for CHD decreased in men and women aged 45–64 years and increased among those aged 65 years or over in Finland from 1990 to 2003. Among those aged 75 years or over, the prevalence doubled from 1990 to 2003 (Erityiskorvattaviin lääkkeisiin oikeuttavat sairaudet 1986–1996; Data in files of the Social Insurance Institution, Finland 2002) (Reunanen, personal communication).

CHD mortality and incidence of acute CHD events have decreased markedly in Finns during the past 25 years (Salomaa et al. 1996a; Salomaa et al. 2003; Statistics Finland 2003a). The decrease has been largest in middle-aged persons and modest in the 65–74 age group (Statistics Finland 1996; Kesteloot et al. 2002). More than half of the decline in mortality from ischaemic heart disease in Finland is explained by changes in the main cardiovascular risk factors (Vartiainen et al. 1994b; Jousilahti et al. 1995). The prevalence of high BP and high serum cholesterol concentration has declined in all adult age groups. Time trends in smoking have also been similar across the age groups: an increase in women and a decrease in men (Vartiainen et al. 2000; Aromaa et al. 2002). The decreases in the prevalence of CHD in Finns aged 45–64 years can also probably be largely explained by changes in risk factors for these diseases. In the oldest age group of 75 years or over, however, the prevalence of CHD has increased, rather than decreased. It has been suggested that the older cohorts would carry their disease burden until old age. The association between different cardiovascular risk factors and subsequent CVD risk among the elderly may be different than among the middle-aged. The association may turn out to be even opposite to that expected at very old age (Mattila et al. 1988; Rajala et al. 1990; Hakala et al. 1997). Declining severity of coronary events (Salomaa et al. 1995) with improvements in the treatment of patients with coronary disease (Salomaa et al. 1999), resulting in improved survival of persons with CHD (Salomaa et al. 1996a; Salomaa et al. 2003), have probably contributed to the shifting of CHD occurrence towards older age groups.

The postponement of the onset of chronic CHD may support compression of the morbidity paradigm, which was presented in 1980 (Fries 1980). However,



improved survival may have the opposite effect. The concept of dynamic equilibrium proposed by Manton suggests that the severity and rate of progression of chronic disease are related to mortality changes, so that with mortality reduction there would also be a reduction in the rate of deterioration of the vital organ systems of the body. This could result in more disease in the population, but at a lower level of severity (Manton 1982). The increase in the prevalence of CHD among persons aged 75 years or more indicates an increase in the burden caused by CHD in this age group. The use of hospital bed days due to CHD increased in the 1980s, especially among the elderly and among women (Palomäki et al. 1993; Pyörälä et al. 1994). According to the statistical database of the register of CVDs, however, it seems that in the 1990s the increase in in-hospital days levelled off and a slight decrease can be observed (National Public Health Institute). The results may indicate that a levelling off or a slight decrease in the prevalence of CHD also occurs in the oldest old, but confirmatory evidence is needed. The hospital discharge register is collected for administrative purposes, and thus the use of diagnoses may vary over time. This makes it difficult to draw firm conclusions on time trends.

There are some reports of time trends in CHD prevalence in middle-aged or elderly persons from other countries. A Swedish study reported a decline in angina symptom-prevalence from 1986 to 1994 for women but not for men aged 35–64 years (Glader et al. 1999). The Reykjavik study showed an increase in the prevalence of MI but a decrease in the prevalence of AP or any manifestation of CHD in men of 65–74 years of age from 1979 to 1987. The same study found that in middle-aged men the prevalence of any manifestation of CHD fell from 1968 to 1986 mainly due to a marked decline in the prevalence of angina without MI (Sigurdsson et al. 1993). Another report relating to the same study recorded an increase in the prevalence of MI in middle-aged and especially in elderly women from 1970 to 1990 (Jonsdottir et al. 1998). A study in the United States involving individuals of 65 years of age or more showed no change in the prevalence of MI, congestive heart failure, or stroke in men and women but an increase in the prevalence of AP in men from 1971 to 1980. In women there was no change (Haan et al. 1996). An United States study analyzing trends in the National Health Interview Survey found that the prevalence of self-reported CHD decreased among men and women aged 45–54 years and increased among men aged 75–84 years from 1980 to 1989 (DeStefano et al. 1993). A study of British men suggested a decline in the prevalence of current angina symptoms but not in the history of diagnosed CHD from 1978 to 1996 (Lampe et al. 2001). It is difficult to draw conclusions of time trends in different countries on the basis of these studies due to differences in the study populations, age groups included, and definitions of CHD.

It may be prudent to say, however, that generally the prevalence rates have declined in younger age groups but that changes in the elderly have varied considerably.

### 6.3.2 Hypertension

The results of study I suggest an increase in the prevalence of hypertension in men and a decrease in women aged 65–74 years in Finland from 1978–1980 to 1997. Other Finnish interview and questionnaire surveys have also shown an increase in the prevalence of self-reported hypertension in men aged 65–74 years. The results of these surveys are contradictory in women (Kivelä et al. 1986; Kalimo et al. 1992; Uutela et al. 1999). Comparisons of results from the Health 2000 Survey with those from the Mini-Finland Survey (1978–1980) suggest that the prevalence of self-reported hypertension has increased in men and women aged 30–64 and 65 or over (Aromaa et al. 2002). Statistics relating to drug reimbursement suggest an increase in the age-adjusted prevalence of hypertension medication in men and a slight decrease in women in the 65–74 age group from 1977 to 1996 (Erityiskorvattaviin lääkkeisiin oikeuttavat sairaudet 1977–1996). The trend in men continued to increase slightly from 1996 to 2003, and in women the decrease levelled off (Data in files of the Social Insurance Institution, Finland 2002) (Reunanen, personal communication). According to the FINRISK Surveys, BP levels in middle-aged individuals have decreased during the past 15 to 25 years (Kastarinen et al. 1998; Vartiainen et al. 2000; Vartiainen et al. 2003). The Health 2000 Survey suggested that BP levels have decreased clearly in all age groups (Aromaa et al. 2002).

The major reasons for the increased prevalence of reported and treated hypertension in men are the improved treatment situation and lowering of the BP levels used as criteria for treatment (Suomen Verenpaineyhdistys ry:n asettama työryhmä 2002). Therefore, the apparent increase in prevalence of hypertension in men in study I mainly reflects improved and more widely used antihypertensive treatment.

### 6.3.3 Heart failure

Our results indicating a marked decrease in the prevalence of heart failure are in line with other Finnish interview and questionnaire surveys (Kivelä et al. 1986; Kalimo et al. 1992; Uutela et al. 1999). Comparisons of the results from the Health 2000 Survey with those from the Mini-Finland Survey also suggest a dramatic decline in the prevalence of heart failure (Aromaa et al. 2002), and this result corresponds well with statistics on the reimbursement of drug costs (Erityiskorvattaviin lääkkeisiin oikeuttavat sairaudet 1977–1996). In 1999, the

prevalence of entitlements to specially-reimbursed medication for heart failure was 5.4% in men aged 65–74 years and 4.8% in women in the same age group (Data in files of the Social Insurance Institution, Finland 2002) (Reunanen, personal communication). These numbers correspond well with the prevalence of clinically diagnosed heart failure observed in our study.

One of the most important causes of this observed decrease is the improvement in the diagnostics of heart failure. Since the early 1990s, diagnostic criteria for heart failure are essentially based on echocardiography, whereas earlier mostly only clinical and radiological criteria were applied. False-positive diagnoses of heart failure were fairly common in primary health care in Finland in the 1980s (Remes et al. 1991). The reduction in prevalence of CHD and improved treatment of hypertension probably also contribute to the reduction in the prevalence of clinically diagnosed heart failure.

The prevalence of clinically diagnosed heart failure has dramatically decreased in Finland. On the other hand, it has been suggested that in some other countries the prevalence of heart failure has increased in recent years (Cowie et al. 1997). Studies in the United States and Scotland, based on hospitalization rates for heart failure, demonstrate an increase in those rates and have been interpreted as showing an increase in the prevalence of heart failure (Ghali et al. 1990; McMurray et al. 1993). However, a population-based study from Rochester, Minnesota, found no changes from 1981 to 1991 in the incidence of heart failure or in survival of patients with heart failure (Senni et al. 1999).

#### **6.3.4 Cerebrovascular disease**

No secular changes were found in the prevalence of cerebrovascular disease. The interpretation of the results is difficult due to the relatively low number of cases.

### **6.4 Cardiovascular diseases as determinants of disability (Studies II and III)**

Our study indicated that CVDs are important determinants of disability in Finns 65–74 years of age. In women, prior MI was a particularly strong determinant of disability, followed by cerebrovascular diseases and heart failure. Of specific CVDs, cerebrovascular disorder was clearly associated with disability in men. Because CVDs were also quite common, a large percentage of disability was attributable to CVDs in the population. Mental disorders and cognitive impairment were even more strongly associated with disability, but these conditions were less prevalent than CVDs in this age group.

Other studies have also found an association between disability and CVDs among the elderly in Finland and in other countries (Lammi et al. 1989a; Lammi et al. 1989b; Stewart et al. 1989; Guccione et al. 1994). However, there are some studies that did not find an association between heart diseases and functional limitations (Ahto et al. 1998; Kivinen et al. 1998; Woo et al. 1998). The lack of association could be connected with a different heart disease pattern or the different measures of disability employed. The varying age categories, different study designs, and measurements of disability make the comparison of our results with other studies difficult. Pinsky et al. found that CHD other than AP was not associated with disability among elderly men and women, although uncomplicated and complicated AP was associated with disability (Pinsky et al. 1990). Another study suggested that both AP and MI may be associated with disability (Stewart et al. 1989). In our study, MI was significantly associated with disability after controlling for other chronic disorders while AP was not. Cerebrovascular disorders were strongly associated with disability and these results are in line with the findings of Guccione et al. (Guccione et al. 1994). After controlling for comorbidity, heart failure was a significant determinant of disability only in women. Similar result was found in the study of Pinsky et al. (Pinsky et al. 1990), possibly due to the very high prevalence of disabling CHD among those men suffering from heart failure.

Our results supported findings from previous studies which have shown women to have higher disability levels than men (Verbrugge et al. 1989; Andersen-Ranberg et al. 1999). It has been suggested that men and women are not disabled by the same conditions (Jette et al. 1988). In our study CVDs were important determinants of disability in both genders. However, a prior MI accounted for more disability in women than in men. In Finland there are no gender differences in in-hospital mortality after acute MI (Schreiner et al. 2001; Salomaa et al. 2003). Prehospital MI mortality is higher in men than in women (Salomaa et al. 2003), and it is possible that more women than men survive with large MIs, resulting in higher disability levels in women.

Due to the cross-sectional design of the study, the time relation of disability and chronic diseases is not known. However, disability may also be a concurrent aspect of a disease or disorder, and not only a consequence appearing over a long follow-up period. The age range of our study population in study II was 65–74 years. It is not possible to extrapolate the role of CVDs as a cause of disability among persons aged 75 years or more on the basis of these results. The results of study III, however, suggested that CHD remains an important determinant of disability in women aged 75 years or more, whereas in men the importance decreases with age. The results of study III also suggest that in women the association between CHD and disability may be even stronger nowadays than 20 years ago. In a population

based study from Canada, the percentage of heart diseases reported as causing disabilities increased from 1986 to 1991 among elderly persons (Raina et al. 1998). CHD will increasingly occur in older age groups, and as the aging of the population continues, the number of persons with CHD may stay at the present level or even increase. Improvements in treatment may improve the functional ability of persons with these diseases, but they also increase the survival of persons suffering from the most severe forms of CHD. Thus, CHD is likely to remain an important determinant of disability in the future.

## **6.5 Secular changes in coronary heart disease related disability burden (Study III)**

Our findings demonstrated for the first time a simultaneous reduction of CHD and disability in the Finnish population. A previous study also suggests that the prevalence of disability in persons aged 65–74 years has decreased in Finland (Martelin et al. 2002). Some other regional studies from Finland also have reported a declining trend in disability among elderly (Jylhä et al. 1992; Pohjolainen et al. 1997; Laukkanen et al. 1999; Pitkälä et al. 2001; Sulander et al. 2001; Malmberg et al. 2002). To my knowledge, there are no studies concerning time trends in disability among persons with chronic CHD in Finland, or in other countries.

The prevalence of disability has decreased significantly in Finns of 45–74 years of age over the last 20 years. The decrease was evident in men with and without CHD and in women without CHD, but no significant decline occurred in women with CHD.

It can be assumed that less severe CHD was better diagnosed at the time of the latter survey than 20 years ago, and this could have increased the observed prevalence of CHD and at the same time decreased the prevalence of disability among persons with CHD.

The results concerning women with CHD may indicate that there are gender differences in the nature of the disease. The results may also indicate that improvements in therapeutic procedures have not been as effective in women as in men; studies from Finland suggest that thrombolytic therapy was administered less frequently to female than to male patients (Miettinen et al. 1999; Salomaa et al. 2003). On the other hand, CHD is more difficult to diagnose in women (Kwok et al. 1999; Wenger 2002), and it may be that false positive cases of CHD were more common in women than in men 20 years ago. The accuracy of the diagnostics of CHD has probably improved, and as a result, the proportion of possible false positive CHD cases may have decreased. This could partly explain why the

functional status of women suffering from CHD has not improved. Prevalence changes of some other chronic disabling diseases or disorders may also partly explain the lack of improvement in functional ability among women with CHD. Our further analyses (data not shown) suggested that among women with CHD, the prevalence of mental disorders and some smoking-related diseases such as chronic bronchitis may have increased more than in women without CHD or in men.

Changes in the prevalence of CHD, and in the prevalence of disability among persons with CHD, explained some of the change in disability among men under the age of 75 years and among women under the age of 65 years at the population level. These results are only rough estimates, and further studies are needed to estimate the impact of other factors on the secular changes in disability at the population level. There must also be other factors contributing to the change in disability at the population level. However, studies assessing these factors are rare. A previous study from Finland concerning persons aged 65–74 years suggested that changes in the prevalence of CVDs and in the educational structure of the population have contributed to the decline in the need for help from 1978–1980 to 1997 (Martelin et al. 2002).

The observed decreases in disability prevalences support the compression of morbidity theory (Fries 1980). It seems that disability rates have decreased most among persons under 65 years of age, moderately among those aged 65–74 years, and least among persons aged 75 years or over. Based on these results only, however, it is not possible to draw conclusions of the general effect of declining disability and increasing life expectancy. If age-specific disability or morbidity rates decline faster than age-specific mortality, then compression is established (Fries 2003). There are some results from Finland suggesting that disability-free life expectancy at age 65 has increased and years lived with disability have decreased during the past 20 years (Sihvonen et al. 2003). Information from other countries also suggests that increased life expectancy is not accompanied by an increase in the time lived with severe disability. Results including also milder disability are diverse. Comparisons between countries are difficult due to differences in the characteristics of national health surveys with regard to protocol or question formulation (Robine et al. 1999).

Our study provides a clear picture of the effect of declining mortality and incidence of acute CHD events on the prevalence of the disease, demonstrating a decrease in the prevalence of CHD among the middle-aged and an increase among men and women aged 75 years or over during the past 20 years in Finland. Improvements in treatment may improve the functional ability of persons with these diseases, but they probably also increase the survival of persons suffering

from the most severe forms of these diseases. Our results concerning the remarkable role of CVDs (especially MI in women) as determinants of disability in the elderly, and results suggesting an increase in the prevalence of CHD among persons aged 75 years or more, suggest an increase in the CHD-related disability burden among the elderly. The burden caused by CHD has not disappeared, but it has shifted to older ages. Adequate care and rehabilitation of elderly persons suffering from these diseases is important. A recent study from Helsinki University Hospital reported that elderly acute MI patients did not receive the same standard of treatment and prevention as younger patients, and the in-hospital mortality was high (Kotamäki et al. 2003). A multifactorial cardiovascular disease prevention study among home-dwelling CVD patients aged 75 years or more aims to clarify whether it is possible to treat the elderly in the real world according to established guidelines and whether this confers clinical benefits (Strandberg et al. 2001a). An American Heart Association Scientific Statement recently called for greater use of secondary preventive therapies in the elderly (Williams et al. 2002). The care of elderly patients, especially elderly women, with CHD, will have important implications on the public health burden.

Good health and functional capacity at old age is a consequence of good health and good care of risk factors and chronic diseases at young and middle ages. Effects of good health habits on subsequent disability are considerable (Vita et al. 1998). Low cardiovascular risk in middle age is associated with lower mortality, morbidity, and better quality of life in old age (Strandberg et al. 2004). Active interventions to reduce risk factors should begin at young adulthood or midlife. The recent increase in the prevalence of obesity among young and middle-aged Finns (Lahti-Koski et al. 2001; Vartiainen et al. 2003; Männistö et al. 2004) and the estimated rising burden of diabetes (Amos et al. 1997; King et al. 1998; Reunanen 2003) may increase CVDs and subsequent disability among the elderly in the future. Elderly persons in better health had longer life-expectancy than those in poorer health, but they did not have higher health care expenditures. Thus, health-promotion efforts under the age of 65 years may improve the health and longevity without increasing health expenditures (Lubitz et al. 2003).

## **6.6 Disability as a predictor of mortality (Study IV)**

In this prospective, population-based study, general disability at baseline was associated with a substantial increase in mortality from CHD and all-causes in middle-aged and younger elderly men with CHD, but the association in women with CHD was not statistically significant. Disability was also associated with excess mortality risk in both men and women with no CHD at baseline.



Our results are in line with studies from acute clinical settings (Brezinski et al. 1991; Vaccarino et al. 1997; Spertus et al. 2002). However, our results can be generalized to all CHD patients in Finland. Our findings suggest that the association between disability and all-cause and CHD mortality may be stronger in men than in women with CHD. A previous study by Vaccarino et al. also suggested that disability was more strongly associated with mortality in men with MI than in women (Vaccarino et al. 1997). Corti et al. found physical disability to double the risk of CHD mortality among elderly men and women in a population based study. However, they did not examine the association between disability and mortality in persons with baseline CHD (Corti et al. 1996).

The differences between men and women in our results may reflect a gender difference in the nature of CHD and also the differing aetiology of disability between men and women. CHD manifestations differ by gender: acute MI and sudden death are the most usual manifestations in men, whereas AP is the most common manifestation in women (Reunanen et al. 1983). Women with AP have a more favourable outlook than men with similar symptoms (Murabito et al. 1993). AP symptoms obtained using the WHO questionnaire did not predict future mortality in women in a Finnish prospective population study, whereas in men they were strong predictors of mortality (Reunanen et al. 1983). This may imply that many women with AP symptoms actually suffer from chest pain due to causes other than CHD. In the present study, the proportion of subjects with previous MI among those with CHD at baseline was higher in men than in women, indicating that CHD was more severe in men than in women. CHD in women may be less disabling, and a higher proportion of disability in women than in men may be due to other, possibly less lethal, causes than CHD. Moreover, disability in women may be different from that in men; men may be more reluctant to report difficulties in ADL than women. In addition, the numbers of cases and deaths were smallest in women with CHD, which may reduce the strength of this interpretation.

The end-point examined in this study was mortality. It should be kept in mind, however, that mortality is not the only measure of suffering and poor prognosis. Based on these results, it is not possible to estimate the impact of disability on future need for help or quality of life, which would be important.

Disability is an excellent marker for the overall burden and severity of disease in older persons, and thus a strong predictor of mortality (Guralnik et al. 1996; Scott et al. 1997; Inouye et al. 1998; Ostbye et al. 1999). On the other hand, it has been reported that objective CHD severity has only a fairly weak connection with self-reported functional status (Sullivan et al. 1996). Activity limitations are also determined by many factors that are not causally associated with increased mortality risk. The measure of disability used in this study was chosen to represent



general and not only CHD-specific disability, and this was the main reason for not using physician-assessed physical functioning (e.g. NYHA-classification).

In middle-aged and younger elderly men, general disability identifies a group at high risk of death from CHD or all-causes. Disability did not predict mortality in the age group of 75 years or more. Among the elderly mortality is possibly determined by factors different from those at younger age. Cardiac rehabilitation is associated with improved outcomes, including reduced mortality and improvements in physical functioning after a cardiac event, regardless of age (Ades et al. 1999; Pasquali et al. 2001). The goals of rehabilitation of older coronary patients are to improve physical functioning and quality of life and to extend disability-free survival (Ades 1999). Interventions that successfully improve physical function in the expanding elderly population with CHD will have important public health implications.

## **6.7 Implications for future research**

Due to positive changes in cardiovascular risk factors and improved treatment of acute MI and chronic CHD, mortality, incidence, and prognosis of CHD have improved. As a result of these changes prevalence of CHD has also declined among working-aged Finns. Among persons aged 75 years or more, however, the prevalence of CHD has increased. CHD will increasingly occur in older age groups, and as the aging of the population continues, the number of persons with CHD may increase.

Changing diagnostic and treatment practices are important in determining the health care burden at a given level of incidence and prevalence of the disease. Consequent disability determines the burden on social services. Better treatment may improve the functional ability of persons with CHD, but it also increases the survival of persons suffering from the most severe forms of the disease. As the population suffering from CHD becomes older, their functional ability becomes more important. It is important to understand the needs of secondary prevention, treatment, and rehabilitation of these elderly CHD patients in order to maintain and improve their functional capacity.

Successful CVD prevention has had a positive effect on functional capacity at the population level. The contribution of secular changes in prevalence and severity of other somatic and mental chronic conditions to different levels of population disability should be examined.

Besides chronic diseases and their treatment, many other factors also determine the functional capacity of the elderly, including many personal, lifestyle, psychosocial, socioeconomic, societal, and environmental factors. Many of these stem from

earlier phases of life. Future research should reveal those modifiable factors which contribute to good functional capacity in older ages. Environmental risk factors have not been properly investigated; changes in the environment also contribute to good physical functioning. Additional research is needed for the development of effective interventions in order to improve the functional capacity of elderly persons. Continuous evaluation of population health, functional status, and the need for help is required for improving the assessment of these conditions and evaluating interventions at population level.

## SUMMARY AND CONCLUSIONS

Prevalence of CHD has decreased in men and women aged 45–64 years, decreased slightly, but not significantly, in the 65–74 age group, and increased significantly among men and women aged 75 years or over in Finland during the past 20 years. The decreased prevalence of ECG Q-wave changes in men aged 65–74 years suggests that in particular the most serious forms of CHD has decreased among them.

Prevalence of clinically diagnosed heart failure decreased substantially in men and women aged 65–74 years. One of the most important causes of this was the reduction in false positive heart failure diagnoses due to improvements in the diagnostics of heart failure over past 20 years. The reduction in prevalence of CHD and improved treatment of hypertension probably also contributed to the reduction in the prevalence of heart failure. Prevalence of hypertension increased in men and decreased in women aged 65–74 years. The apparent increase in men was mainly due to improved and more widely used antihypertensive treatment.

CVDs are important determinants of disability among Finns aged 65–74 years. In men, a third and in women a fourth of disability was attributable to CVD, excluding hypertension alone. Of specific CVDs, cerebrovascular diseases, and in women also MI and heart failure, were the most important determinants of disability. A prior MI in women was even more strongly associated with disability than heart failure and cerebrovascular disorders.

Functional ability has improved in Finns up to 74 years of age over the past 20 years. The decrease in disability was observed in men with and without CHD and in women without CHD, but in women with CHD the decrease was not statistically significant. During the past 20 years in Finland, the decreased prevalence of CHD together with changes in functional ability among persons with CHD explained a fifth of the improvement in functional capacity in men aged 45–64 years, a fourth in men aged 65–74 years, and 17% in women aged 45–64 years. However, in men aged 75 years or over and in women aged 65 years or over, the CHD-related disability-burden tended to increase. The burden caused by CHD has not disappeared, but it has shifted to older ages. In particular, elderly women with CHD need more attention in order to prevent the burden caused by CHD and its consequences to increase.

Disability predicted mortality from CHD and all-causes in men with and without baseline CHD, and in women without CHD. In women with CHD, disability seemed not to be related to excess mortality. This may reflect a gender difference in the nature of CHD, and also a differing aetiology of disability between men and women, but these findings need to be verified in other large-scale population studies.

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## REFERENCES

- Abrahamsson P, Dellborg M, Rosengren A and Wilhelmsen L. Improved long-term prognosis after myocardial infarction 1984–1991. *Eur Heart J* 1998;19:1512-7.
- Ades PA. Cardiac rehabilitation in older coronary patients. *J Am Geriatr Soc* 1999;47:98-105.
- Ades PA, Maloney A, Savage P and Carhart RL, Jr. Determinants of physical functioning in coronary patients: response to cardiac rehabilitation. *Arch Intern Med* 1999;159:2357-60.
- Ahacic K, Parker MG and Thorslund M. Mobility limitations in the Swedish population from 1968 to 1992: age, gender and social class differences. *Aging (Milano)* 2000;12:190-8.
- Aho K. Incidence, profile and early prognosis of stroke (Thesis). University of Helsinki. Helsinki, 1975.
- Ahto M, Isoaho R, Puolijoki H, Laippala P, Romo M and Kivelä SL. Functional abilities of elderly coronary heart disease patients. *Aging (Milano)* 1998;10:127-36.
- Alderman MH. Measures and meaning of blood pressure. *Lancet* 2000;355:159.
- Amos AF, McCarty DJ and Zimmet P. The rising global burden of diabetes and its complications: estimates and projections to the year 2010. *Diabet Med* 1997;14 Suppl 5:S1-85.
- Andersen-Ranberg K, Christensen K, Jeune B, Skytthe A, Vasegaard L and Vaupel JW. Declining physical abilities with age: a cross-sectional study of older twins and centenarians in Denmark. *Age Ageing* 1999;28:373-7.
- Anttila S. Functional capacity in two elderly populations aged 75 or over: comparisons at 10 years' interval. *J Clin Epidemiol* 1991;44:1181-6.
- Arinen S, Häkkinen U, Klaukka T, Klavus J, Lehtonen R and Aro S. Health and the Use of Health Services in Finland. Main findings of the Finnish Health Care Survey 1995/96 and changes from 1987. National Research and Development Centre for Welfare and Health and The Social Insurance Institution, Finland, publication series Health Care 1998:5. Helsinki, 1998.
- Aromaa A. Kohonnut verenpaine ja sen kansanterveydellinen merkitys Suomessa (Epidemiology and public health impact of high blood pressure in Finland; in Finnish with English summary). Kansaneläkelaitoksen julkaisuja / Publications of the Social Insurance Institution AL:17. Helsinki, 1981.
- Aromaa A. Verenpaineen mittaamisen ja mittaustulosten arviointi: Kansaneläkelaitoksen autoklinikan moniseulontatutkimus 1966–1972 (Evaluation of Blood Pressure Measurement. The Social Insurance Institution's Mobile Clinic Health Survey, 1966–1972; in Finnish with English summary). Kansaneläkelaitoksen julkaisuja/ Publications of the Social Insurance Institution ML:28. Helsinki, 1982.
- Aromaa A, Heliövaara M, Impivaara O, Knekt P and Maatela J. Mini-Suomi-terveys tutkimuksen toteutus. Osa 1: Tavoitteet, menetelmät ja aineisto (The execution of the Mini-Finland Health Survey. Part 1: Aims, methods and study population; in Finnish with English summary). Kansaneläkelaitoksen julkaisuja/ Publications of the Social Insurance Institution ML:88. Helsinki and Turku, 1989a.

- Aromaa A, Heliövaara M, Impivaara O, Knekt P, Maatela J, Joukamaa M, Klaukka T, Lehtinen V, Melkas T, Mälikä E, Nyman K, Paunio I, Reunanen A, Sievers K, Kalimo E and Kallio V. Terveys, toimintakyky ja hoidontarve Suomessa. Mini-Suomi-terveystutkimuksen perustulokset (Health, functional limitations and need for care in Finland. Basic results from the Mini-Finland Health Survey; in Finnish with English summary). Kansaneläkelaitoksen julkaisuja/Publications of the Social Insurance Institution AL:32. Helsinki and Turku, 1989b.
- Aromaa A and Koskinen S, eds. Terveys ja toimintakyky Suomessa. Terveys 2000 - tutkimuksen perustulokset (Health and functional capacity in Finland. Baseline results of the Health 2000 survey; in Finnish with English summary). Publications of the National Public Health Institute B3/2002. Helsinki, 2002. Available at: <http://www.ktl.fi/terveys2000/perusraportti/index.html>.
- Aromaa A, Koskinen S and Huttunen J, eds. Health in Finland. National Public Health Institute and Ministry of Social Affairs and Health. Helsinki, 1999.
- Barker WH, Mullooly JP and Linton KL. Trends in hypertension prevalence, treatment, and control: in a well-defined older population. *Hypertension* 1998;31:552-9.
- Beller GA. Coronary heart disease in the first 30 years of the 21st century: challenges and opportunities: The 33rd Annual James B. Herrick Lecture of the Council on Clinical Cardiology of the American Heart Association. *Circulation* 2001;103: 2428-35.
- Berg M-A, Peltoniemi J and Puska P. Suomalaisen aikuisväestön terveyskäyttäytyminen kevät 1990 (Health behaviour among Finnish adult population spring 1990; in Finnish with English summary and tables). Publications of the National Public Health Institute B3/1990. Helsinki, 1990.
- Bild DE, Fitzpatrick A, Fried LP, Wong ND, Haan MN, Lyles M, Bovill E, Polak JF and Schulz R. Age-related trends in cardiovascular morbidity and physical functioning in the elderly: the Cardiovascular Health Study. *J Am Geriatr Soc* 1993;41:1047-56.
- Blumenthal RS, Cohn G and Schulman SP. Medical therapy versus coronary angioplasty in stable coronary artery disease: a critical review of the literature. *J Am Coll Cardiol* 2000;36:668-73.
- Boersma E, Mercado N, Poldermans D, Gardien M, Vos J and Simoons ML. Acute myocardial infarction. *Lancet* 2003;361:847-58.
- Boult C, Kane RL, Louis TA, Boult L and McCaffrey D. Chronic conditions that lead to functional limitation in the elderly. *J Gerontol* 1994;49:M28-36.
- Branch LG, Katz S, Kniepmann K and Papsidero JA. A prospective study of functional status among community elders. *Am J Public Health* 1984;74:266-8.
- Branch LG and Meyers AR. Assessing physical function in the elderly. *Clin Geriatr Med* 1987;3:29-51.
- Breslow NE and Day NE. Statistical methods in cancer research. Volume II – The design and analysis of cohort studies. IARC Scientific Publications no.82. Lyon, 1987.
- Brezinski D, Stone PH, Muller JE, Tofler GH, Davis V, Parker C, Hartley LH and Braunwald E. Prognostic significance of the Karnofsky Performance Status score in patients with acute myocardial infarction: comparison with the left ventricular ejection fraction and the exercise treadmill test performance. The MILIS Study Group. *Am Heart J* 1991;121:1374-81.

- Brock DB, Lemke JH, Branch LG, Evans DA and Berkman LF. Mortality and physical functioning in epidemiologic studies of three older populations. *J Aging Soc Policy* 1994;6:21-37.
- Carlson KJ, Lee DC, Goroll AH, Leahy M and Johnson RA. An analysis of physicians' reasons for prescribing long-term digitalis therapy in outpatients. *J Chronic Dis* 1985;38:733-9.
- Carr JJ and Drekter IJ. Simplified rapid technic for the extraction and determination of serum cholesterol without saponification. *Clin Chem* 1956;2:353-68.
- Chirikos TN and Nickel JL. Work disability from coronary heart disease in women. *Women & Health* 1984;9:55-74.
- Cleland JG, Gemmell I, Khand A and Boddy A. Is the prognosis of heart failure improving? *Eur J Heart Fail* 1999;1:229-41.
- Corti MC, Guralnik JM, Salive ME and Sorkin JD. Serum albumin level and physical disability as predictors of mortality in older persons. *JAMA* 1994;272:1036-42.
- Corti MC, Salive ME and Guralnik JM. Serum albumin and physical function as predictors of coronary heart disease mortality and incidence in older persons. *J Clin Epidemiol* 1996;49:519-26.
- Cowie MR, Mosterd A, Wood DA, Deckers JW, Poole-Wilson PA, Sutton GC and Grobbee DE. The epidemiology of heart failure. *Eur Heart J* 1997;18:208-25.
- Cowie MR, Wood DA, Coats AJ, Thompson SG, Poole-Wilson PA, Suresh V and Sutton GC. Incidence and aetiology of heart failure; a population-based study. *Eur Heart J* 1999;20:421-8.
- Cox D. Regression models and life-tables. *J R Stat Soc B* 1972;34:187-220.
- Crimmins EM, Saito Y and Reynolds SL. Further evidence on recent trends in the prevalence and incidence of disability among older Americans from two sources: the LSOA and the NHIS. *J Gerontol B Psychol Sci Soc Sci* 1997;52:S59-71.
- Data in files of the Social Insurance Institution, Finland. 2002.
- Davies M, Hobbs F, Davis R, Kenkre J, Roalfe AK, Hare R, Wosornu D and Lancashire RJ. Prevalence of left-ventricular systolic dysfunction and heart failure in the Echocardiographic Heart of England Screening study: a population based study. *Lancet* 2001;358:439-44.
- Davis RC, Hobbs FD and Lip GY. ABC of heart failure. History and epidemiology. *BMJ* 2000;320:39-42.
- Denolin H, Kuhn H, Krayenbuehl HP, Loogen F and Reale A. The definition of heart failure. *Eur Heart J* 1983;4:445-8.
- DeStefano F, Merritt RK, Anda RF, Casper ML and Eaker ED. Trends in nonfatal coronary heart disease in the United States, 1980 through 1989. *Arch Intern Med* 1993;153:2489-94.
- Dewhurst G, Wood DA, Walker F, Lampe FC, Jeffreys M, Cooper M and Williams JD. A population survey of cardiovascular disease in elderly people: design, methods and prevalence results. *Age & Ageing* 1991;20:353-60.

- Di Bari M, Marchionni N, Ferrucci L, Pini R, Antonini E, Chiarlone M, Marsilii A, De Alfieri W, Fumagalli S and Masotti G. Heart failure in community-dwelling older persons: aims, design and adherence rate of the ICARe Dicomano project: an epidemiologic study. *Insufficienza Cardiaca negli Anziani Residenti a Dicomano. J Am Geriatr Soc* 1999;47:664-71.
- Eriksson H. Heart failure: a growing public health problem. *J Intern Med* 1995;237:135-41.
- Erityiskorvattaviin lääkkeisiin oikeuttavat sairaudet. Kansaneläkelaitoksen julkaisuja / Publications of the Social Insurance Institution T6. Helsinki, 1977-1996.
- Erityiskorvattaviin lääkkeisiin oikeuttavat sairaudet. Kansaneläkelaitoksen julkaisuja / Publications of Social Insurance Institution T6. Helsinki, 1986-1996.
- Ettinger WH, Jr., Fried LP, Harris T, Shemanski L, Schulz R and Robbins J. Self-reported causes of physical disability in older people: the Cardiovascular Health Study. CHS Collaborative Research Group [see comments]. *J Am Geriatr Soc* 1994;42:1035-44.
- Fang J and Alderman MH. Trend of stroke hospitalization, United States, 1988-1997. *Stroke* 2001;32:2221-6.
- Folstein MF, Folstein SE and McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res* 1975; 12:189-98.
- Freedman VA, Martin LG and Schoeni RF. Recent trends in disability and functioning among older adults in the United States: a systematic review. *JAMA* 2002; 288:3137-46.
- Fried LP, Bandeen-Roche K, Kasper JD and Guralnik JM. Association of comorbidity with disability in older women: the Women's Health and Aging Study. *J Clin Epidemiol* 1999;52:27-37.
- Fried LP, Ettinger WH, Lind B, Newman AB and Gardin J. Physical disability in older adults: a physiological approach. Cardiovascular Health Study Research Group. *J Clin Epidemiol* 1994;47:747-60.
- Fried LP and Guralnik JM. Disability in older adults: evidence regarding significance, etiology, and risk. *J Am Geriatr Soc* 1997;45:92-100.
- Fried LP, Kronmal RA, Newman AB, Bild DE, Mittelmark MB, Polak JF, Robbins JA and Gardin JM. Risk factors for 5-year mortality in older adults: the Cardiovascular Health Study. *JAMA* 1998;279:585-92.
- Fries JF. Aging, natural death, and the compression of morbidity. *N Engl J Med* 1980; 303:130-5.
- Fries JF. Measuring and monitoring success in compressing morbidity. *Ann Intern Med* 2003;139:455-9.
- Ghali JK, Cooper R and Ford E. Trends in hospitalization rates for heart failure in the United States, 1973-1986. Evidence for increasing population prevalence. *Arch Intern Med* 1990;150:769-73.
- Glader EL and Stegmayr B. Declining prevalence of angina pectoris in middle-aged men and women. A population-based study within the Northern Sweden MONICA Project. Multinational Monitoring of Trends and Cardiovascular Disease. *J Intern Med* 1999;246:285-91.
- Greenland S. Bias in methods for deriving standardized morbidity ratio and attributable fraction estimates. *Stat Med* 1984;3:131-41.



- Greenland S and Drescher K. Maximum likelihood estimation of the attributable fraction from logistic models. *Biometrics* 1993;49:865-72.
- Guccione AA, Felson DT, Anderson JJ, Anthony JM, Zhang Y, Wilson PW, Kelly-Hayes M, Wolf PA, Kregar BE and Kannel WB. The effects of specific medical conditions on the functional limitations of elders in the Framingham Study. *Am J Public Health* 1994;84:351-8.
- Guidelines Subcommittee. 1999 World Health Organization-International Society of Hypertension Guidelines for the Management of Hypertension. *J Hypertens* 1999; 17:151-83.
- Guralnik JM, Fried LP and Salive ME. Disability as a public health outcome in the aging population. *Annu Rev Public Health* 1996;17:25-46.
- Guralnik JM and Simonsick EM. Physical disability in older Americans. *J Gerontol* 1993;48 Spec No:3-10.
- Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, Scherr PA and Wallace RB. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J Gerontol* 1994;49:M85-94.
- Haan MN, Selby JV, Quesenberry CP, Jr., Schmittdiel JA, Fireman BH and Rice DP. The impact of aging and chronic disease on use of hospital and outpatient services in a large HMO: 1971–1991 [see comments]. *J Am Geriatr Soc* 1997;45:667-74.
- Haan MN, Selby JV, Rice DP, Quesenberry CP, Jr., Schofield KA, Liu J and Fireman BH. Trends in cardiovascular disease incidence and survival in the elderly. *Ann Epidemiol* 1996;6:348-56.
- Haapanen N, Miilunpalo S, Pasanen M, Oja P and Vuori I. Agreement between questionnaire data and medical records of chronic diseases in middle-aged and elderly Finnish men and women. *Am J Epidemiol* 1997;145:762-9.
- Haavisto M, Geiger U, Mattila K and Rajala S. A health survey of the very aged in Tampere, Finland. *Age Ageing* 1984;13:266-72.
- Hakala SM, Tilvis RS and Strandberg TE. Blood pressure and mortality in an older population. A 5-year follow-up of the Helsinki Ageing Study. *Eur Heart J* 1997; 18:1019-23.
- Haldeman GA, Croft JB, Giles WH and Rashidee A. Hospitalization of patients with heart failure: National Hospital Discharge Survey, 1985 to 1995. *Am Heart J* 1999; 137:352-60.
- Hankey GJ, Jamrozik K, Broadhurst RJ, Forbes S and Anderson CS. Long-term disability after first-ever stroke and related prognostic factors in the Perth Community Stroke Study, 1989-1990. *Stroke* 2002;33:1034-40.
- Harris T, Kovar MG, Suzman R, Kleinman JC and Feldman JJ. Longitudinal study of physical ability in the oldest-old. *Am J Public Health* 1989;79:698-702.
- Hartikainen S, Ahto M, Löppönen M, Puolijoki H, Laippala P, Ojanlatva A, Kivelä SL and Isoaho R. Change in the prevalence of coronary heart disease among Finnish elderly men and women in the 1990s. *Scand J Prim Health Care* 2003;21:178-81.
- Heikkinen E, Arajärvi RL, Era P, Jylhä M, Kinnunen V, Leskinen AL, Leskinen E, Mässeli E, Pohjolainen P and Rahkila P. Functional capacity of men born in 1906–10, 1926–30 and 1946–50. A basic report. *Scand J Soc Med Suppl* 1984;33:97p.

- Heikkinen E, Arajärvi R-L, Jylhä M, Koskinen S, Pekurinen M and Pohjolainen P. Eläkeikäiset Tampereella: haastattelututkimus 60–89-vuotiaiden tamperelaisten terveydentilasta, toimintakykyisyydestä, palvelujen käytöstä ja elintavoista (The elderly in the city of Tampere. A study on health status, functional ability, use of services and individual way of life of the 60–89 years old people in Tampere; in Finnish with English summary). *Kansanterveystieteen julkaisuja* M:65. Tampere, 1981.
- Heikkinen E, Heikkinen R-L, Kauppinen M, Laukkanen P, Ruoppila I and Suutama T. Iäkkäiden henkilöiden toimintakyky. Ikivihreät-projekti. Osa I (Functional capacity in the elderly. Evergreen-project. Part I; in Finnish with English summary). *Sosiaali- ja terveysministeriön suunnitteluosasto 1990:1*. Helsinki, 1990.
- Heikkinen R-L and Suutama T, eds. Iäkkäiden henkilöiden toimintakyvyn ja terveyden arviointi. Ikivihreät-projekti. Osa II (Evaluating the functional capacity and health of the elderly; in Finnish with English summary). *Sosiaali- ja terveysministeriön kehittämisosaston julkaisuja 1991:10*. Helsinki, 1992.
- Helakorpi S, Patja K, Prättälä R, Aro AR and Uutela A. Suomalaisen aikuisväestön terveyskäyttäytyminen ja terveys, kevät 2002 (Health Behaviour and Health among Finnish Adult Population, Spring 2002; in Finnish with English summary and tables). *Publications of the National Public Health Institute B12/2002*. Helsinki, 2002.
- Helakorpi S, Uutela A, Prättälä R and Puska P. Suomalaisen aikuisväestön terveyskäyttäytyminen, kevät 1998 (Health Behaviour among Finnish Adult Population, Spring 1998; in Finnish with English summary and tables). *Publications of the National Public Health Institute B10/1998*. Helsinki, 1998.
- Heliövaara M, Aromaa A, Klaukka T, Knekt P, Joukamaa M and Impivaara O. Reliability and validity of interview data on chronic diseases. The Mini-Finland Health Survey. *J Clin Epidemiol* 1993;46:181-91.
- Henderson RA, Pocock SJ, Clayton TC, Knight R, Fox KA, Julian DG and Chamberlain DA. Seven-year outcome in the RITA-2 trial: coronary angioplasty versus medical therapy. *J Am Coll Cardiol* 2003;42:1161-70.
- Hetemaa T, Keskimäki I, Manderbacka K, Leyland AH and Koskinen S. How did the recent increase in the supply of coronary operations in Finland affect socio-economic and gender equity in their use? *J Epidemiol Community Health* 2003;57:178-85.
- Hirvensalo M, Rantanen T and Heikkinen E. Mobility difficulties and physical activity as predictors of mortality and loss of independence in the community-living older population. *J Am Geriatr Soc* 2000;48:493-8.
- Hoeymans N, Feskens EJ, Van Den Bos GA and Kromhout D. Non-response bias in a study of cardiovascular diseases, functional status and self-rated health among elderly men. *Age Ageing* 1998;27:35-40.
- Immonen-Räihä P, Arstila M, Tuomilehto J, Haikio M, Mononen A, Vuorenmaa T, Torppa J and Parvinen I. 21 year trends in incidence of myocardial infarction and mortality from coronary disease in middle-age. *Eur Heart J* 1996;17:1495-502.
- Immonen-Räihä P, Mähönen M, Tuomilehto J, Salomaa V, Kaarsalo E, Narva EV, Salmi K, Sarti C, Sivenius J, Alhainen K and Torppa J. Trends in case-fatality of stroke in Finland during 1983 to 1992. *Stroke* 1997;28:2493-9.

- Immonen-Räihä P, Sarti C, Tuomilehto J, Torppa J, Lehtonen A, Sivenius J, Mononen A and Narva EV. Eleven-year trends of stroke in Turku, Finland. *Neuroepidemiology* 2003;22:196-203.
- Inouye SK, Peduzzi PN, Robison JT, Hughes JS, Horwitz RI and Concato J. Importance of functional measures in predicting mortality among older hospitalized patients. *JAMA* 1998;279:1187-93.
- Jette AM, Pinsky JL, Branch LG, Wolf PA and Feinleib M. The Framingham Disability Study: physical disability among community-dwelling survivors of stroke. *J Clin Epidemiol* 1988;41:719-26.
- Joensuu T. Sairaalahoitoon tai kuolemaan johtanut sepelvaltimotauti Suomessa vuosina 1972–1985 (Ischaemic heart disease leading to hospitalization or death in Finland 1972–1985; in Finnish with English summary). Health Services Research by the National Board of Health in Finland, 52. Helsinki, 1989.
- Jonsdottir LS, Sigfusson N, Sigvaldason H and Thorgeirsson G. Incidence and prevalence of recognised and unrecognised myocardial infarction in women. The Reykjavik Study. *Eur Heart J* 1998;19:1011-8.
- Jousilahti P, Vartiainen E, Tuomilehto J, Pekkanen J and Puska P. Effect of risk factors and changes in risk factors on coronary mortality in three cohorts of middle-aged people in eastern Finland. *Am J Epidemiol* 1995;141:50-60.
- Jousilahti P, Vartiainen E, Tuomilehto J and Puska P. Sex, age, cardiovascular risk factors, and coronary heart disease: a prospective follow-up study of 14 786 middle-aged men and women in Finland. *Circulation* 1999;99:1165-72.
- Jylhä M, ed. Vanhuusikä muutoksessa – kohorttitutkimus eläkeikäisten tamperelaisten terveydestä ja elämäntilanteesta vuosina 1979 ja 1989 (Old age in transition – a cohort comparison of the health and life situation of the elderly in Tampere in 1979 and 1989; in Finnish with English summary). Sosiaali- ja terveysministeriön selvityksiä 6. Helsinki, 1993.
- Jylhä M, Jokela J, Tolvanen E, Heikkinen E, Heikkinen RL, Koskinen S, Leskinen E, Lyyra AL and Pohjolainen P. The Tampere Longitudinal Study on Ageing. Description of the study. Basic results on health and functional ability. *Scand J Soc Med Suppl* 1992;47:1-58.
- Kalimo E, Klaukka T, Lehtonen R and Nyman K. Suomalaisten terveysturva ja sen kehitystarpeet. Terveysturvan väestötutkimuksen 1987 päätulokset (Health Security in Finland and Needs for Development. Main Results of a Nationwide Health Security Survey Conducted in 1987; in Finnish with English summary). Kansaneläkelaitoksen julkaisuja/Publications of the Social Insurance Institution M:81. Helsinki, 1992.
- Kalimo E, Nyman K, Klaukka T, Tuomikoski H and Savolainen E. Terveyspalvelusten tarve, käyttö ja kustannukset 1964–1976 (Need, use and expenses of health services in Finland 1964–1976; in Finnish with English summary). Kansaneläkelaitoksen julkaisuja / Publications of the Social Insurance Institution A:18. Helsinki, 1982.
- Kallio V, Hämäläinen H, Hakkila J and Luurila OJ. Reduction in sudden deaths by a multifactorial intervention programme after acute myocardial infarction. *Lancet* 1979;2:1091-4.
- Kannel WB and Belanger AJ. Epidemiology of heart failure. *Am Heart J* 1991;121:951-7.

- Kannel WB and Vokonas PS. Demographics of the prevalence, incidence, and management of coronary heart disease in the elderly and in women. *Ann Epidemiol* 1992;2:5-14.
- Kastarinen MJ, Salomaa VV, Vartiainen EA, Jousilahti PJ, Tuomilehto JO, Puska PM and Nissinen AM. Trends in blood pressure levels and control of hypertension in Finland from 1982 to 1997. *J Hypertens* 1998;16:1379-87.
- Katz S, Downs TD, Cash HR and Grotz RC. Progress in development of the index of ADL. *Gerontologist* 1970;10:20-30.
- Katz S, Ford AB, Moskowitz RW, Jackson BA and Jaffe MW. Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychosocial function. *JAMA* 1963;185:914-9.
- Keil JE, Gazes PC, Sutherland SE, Rust PF, Branch LG and Tyroler HA. Predictors of physical disability in elderly blacks and whites of the Charleston Heart Study. *J Clin Epidemiol* 1989;42:521-9.
- Kesteloot H, Sans S and Kromhout D. Evolution of all-causes and cardiovascular mortality in the age-group 75–84 years in Europe during the period 1970–1996; a comparison with worldwide changes. *Eur Heart J* 2002;23:384-98.
- Khaw KT. How many, how old, how soon? *BMJ* 1999;319:1350-2.
- King H, Aubert RE and Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections. *Diabetes Care* 1998;21:1414-31.
- Kivelä S-L, Piha T, Niemensivu H and Eronen A. Eläkeikäisen väestön terveyskäyttäytyminen kevät 1985. (Health Behaviour of the Finnish Elderly Spring 1985, in Finnish.). Kansanterveyslaitoksen julkaisuja/Publications of the National Public Health Institute B2/1986. Helsinki, 1986.
- Kivinen P, Sulkava R, Halonen P and Nissinen A. Self-reported and performance-based functional status and associated factors among elderly men: the Finnish cohorts of the Seven Countries Study. *J Clin Epidemiol* 1998;51:1243-52.
- Klaukka T. Verenpainetauti edelleen yleisin kansantauti. Diabetes yleistyy nopeasti. *Suom Lääkäril* 2003;58:1310-2.
- Konu V. Myocardial infarction in the elderly. A clinical and epidemiological study with a one-year follow-up. *Acta Med Scand Suppl* 1977;604:3-68.
- Koskinen S. Origins of regional differences in mortality from ischaemic heart disease in Finland. National Research and Development Centre for Welfare and Health, Research reports 41. Helsinki, 1994.
- Koskinen S. Miksi kuolleisuus sepelvaltimotautiin on suurempi Itä-Suomessa kuin Länsi-Suomessa? *Suom Lääkäril* 1995;50:3419-28.
- Kotamäki M, Strandberg TE and Nieminen MS. Clinical findings, outcome and treatment in patients > or = 75 years with acute myocardial infarction. *Eur J Epidemiol* 2003; 18:781-6.
- Koyano W, Shibata H, Haga H and Suyama Y. Prevalence and outcome of low ADL and incontinence among the elderly: five years follow-up in a Japanese urban community. *Arch Gerontol Geriatr* 1986;5:197-206.
- Kupari M, Lindroos M, Iivanainen AM, Heikkilä J and Tilvis R. Congestive heart failure in old age: prevalence, mechanisms and 4-year prognosis in the Helsinki Ageing Study. *J Intern Med* 1997;241:387-94.

- Kwok Y, Kim C, Grady D, Segal M and Redberg R. Meta-analysis of exercise testing to detect coronary artery disease in women. *Am J Cardiol* 1999;83:660-6.
- La Vecchia C, Levi F, Lucchini F and Negri E. Trends in mortality from major diseases in Europe, 1980-1993. *Eur J Epidemiol* 1998;14:1-8.
- Laatikainen T, Tapanainen H, Alfthan G, Salminen I, Sundvall J, Leiviskä J, Harald K, Jousilahti P, Salomaa V and Vartiainen E. FINRISKI 2002. Tutkimuksen toteutus ja tulokset 1. Perusraportti. (FINRISKI 2002. The execution of the survey and results 1. Basic report; in Finnish with English summary). Publications of the National Public Health Institute B7/2003. Helsinki, 2003.
- Lahelma E, Rahkonen O and Huuhka M. Changes in the social patterning of health? The case of Finland 1986-1994. *Soc Sci Med* 1997;44:789-99.
- Lahti-Koski M, Jousilahti P and Pietinen P. Secular trends in body mass index by birth cohort in eastern Finland from 1972 to 1997. *Int J Obes Relat Metab Disord* 2001;25:727-34.
- Lammi UK, Kivelä SL, Nissinen A, Laippala P, Punsar S, Puska P and Karvonen M. Predictors of high functional capacity and mortality in elderly Finnish men. *Aging (Milano)* 1990;2:65-77.
- Lammi UK, Kivelä SL, Nissinen A, Pekkanen J and Punsar S. Functional capacity and associated factors in elderly Finnish men. *Scand J Soc Med* 1989a;17:67-75.
- Lammi UK, Kivelä SL, Nissinen A, Punsar S, Puska P and Karvonen M. Predictors of disability in elderly Finnish men – a longitudinal study. *J Clin Epidemiol* 1989b;42:1215-25.
- Lampe FC, Morris RW, Whincup PH, Walker M, Ebrahim S and Shaper AG. Is the prevalence of coronary heart disease falling in British men? *Heart* 2001;86:499-505.
- Lampe FC, Walker M, Lennon LT, Whincup PH and Ebrahim S. Validity of a self-reported history of doctor-diagnosed angina. *J Clin Epidemiol* 1999;52:73-81.
- Laukkanen P, Leinonen R, Sakari-Rantala R and Heikkinen E. Terveystila ja päivittäisistä toiminnoista selviytyminen 65–69-vuotiailla jyvaskyläläisillä vuosina 1988 ja 1996 (Health status and performance in the activities of daily living among 65–69-year-old residents of Jyväskylä in 1988 and 1996; in Finnish with English summary). In: Heikkinen, E, Lampinen, P and Suutama, T, eds. Kohorttierot 65–69-vuotiaiden henkilöiden toimintakyvyssä, terveydessä ja harrastustoiminnoissa. Havainnot ja ikivihreät-projektin kohorttivertailututkimuksesta vuosilta 1988 ja 1996 (Cohort differences in the functional capacity, health and leisure activities of 65–69 year-old persons. Observations from the cohort comparisons of the Evergreen project in 1988 and 1996). Kansaneläkelaitos, Sosiaali- ja terveysturvan tutkimuksia / The Social Insurance Institution, Studies in social security and health 47. Helsinki, 1999: 47-66.
- Lawton MP and Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist* 1969;9:179-86.
- Lee J. Covariance adjustment of rates based on the multiple logistic regression model. *J Chronic Dis* 1981;34:415-26.
- Lehtonen A and Tilvis R. Turun vanhustutkimus. Turkulaisten 70-vuotiaiden terveydentila, toimintakyky ja terveystalvelujen tarve. Turun kaupungin terveydenhuollon julkaisuja 10. Turku, 1994.

- Lehtonen R and Kuusela V. Mini-Suomi-terveys tutkimuksen toteutus. Osa 5. Mini-Suomi-terveys tutkimuksen otanta-asetelman tilastollinen tehokkuus (The execution of the Mini-Finland Health Survey. Part 5. Statistical efficiency of the Mini-Finland Health Survey's sampling design; in Finnish with English summary). Kansaneläkelaitoksen julkaisuja/Publications of the Social Insurance Institution ML:65. Helsinki and Turku, 1986.
- Lerner DJ and Kannel WB. Patterns of coronary heart disease morbidity and mortality in the sexes: a 26-year follow-up of the Framingham population. *Am Heart J* 1986;111:383-90.
- Lloyd-Jones DM, Evans JC, Larson MG, O'Donnell CJ, Wilson PW and Levy D. Cross-classification of JNC VI blood pressure stages and risk groups in the Framingham Heart Study. *Arch Intern Med* 1999;159:2206-12.
- Lubitz J, Cai L, Kramarow E and Lentzner H. Health, life expectancy, and health care spending among the elderly. *N Engl J Med* 2003;349:1048-55.
- Luoto R, Laine M, Alha P, Koskinen S, Martelin T, Reunanen A, Virtala E and Aromaa A. Terveys ja hoidontarve tautiryhmittäin uudellamaalla 1996–2010. Väli­raportti Uudenmaan väestön hoidontarvetta arvioivan hankkeen (UHOTA-projekti) vaiheesta 2 (Disease-specific health care needs in Uusimaa area 1996–2010. The second phase of the project evaluating health and health needs among the population of Uusimaa – intermediary report; in Finnish with English summary). Publications of the National Public Health Institute B14/1999. Helsinki, 1999.
- Luoto R, Laine M, Alha P, Koskinen S, Martelin T, Reunanen A, Virtala E and Aromaa A. Terveys ja hoidontarve alueittain Suomessa 1996–2010. Uudenmaan väestön hoidontarve (UHOTA) -projektin loppuraportti (Final report from the second phase of the project evaluating health and health care needs among the population of Uusimaa; in Finnish with English summary). Publications of the National Public Health Institute B2/2000. Helsinki, 2000.
- Magaziner J, Bassett SS and Hebel JR. Predicting performance on the Mini-Mental State Examination. Use of age- and education-specific equations. *J Am Geriatr Soc* 1987;35:996-1000.
- Malmberg JJ, Miilunpalo SI, Vuori IM, Pasanen ME, Oja P and Haapanen-Niemi NA. Improved functional status in 16 years of follow up of middle aged and elderly men and women in north eastern Finland. *J Epidemiol Community Health* 2002;56:905-12.
- Manton KG. Changing concepts of morbidity and mortality in the elderly population. *Milbank Mem Fund Q Health Soc* 1982;60:183-244.
- Manton KG. A longitudinal study of functional change and mortality in the United States. *J Gerontol* 1988;43:S153-61.
- Manton KG, Corder L and Stallard E. Chronic disability trends in elderly United States populations: 1982–1994. *Proc Natl Acad Sci U S A* 1997;94:2593-8.
- Manton KG and Gu X. Changes in the prevalence of chronic disability in the United States black and nonblack population above age 65 from 1982 to 1999. *Proc Natl Acad Sci U S A* 2001;98:6354-9.
- Marantz PR, Tobin JN, Wassertheil-Smoller S, Steingart RM, Wexler JP, Budner N, Lense L and Wachspress J. The relationship between left ventricular systolic function and congestive heart failure diagnosed by clinical criteria. *Circulation* 1988;77:607-12.



- Martelin T, Koskinen S, Kattainen A, Sainio P, Reunanen A and Aromaa A. Changes and differentials in the prevalence of activity limitations among Finns aged 65–74: Comparison of the Mini-Finland Health Examination Survey (1978-80) and the FINRISK-97 Senior Survey (1997). *Yearbook of population research in Finland* 2002;38:55-75.
- Martelin T, Koskinen S and Sihvonen A-P. Elinaika ja kuolemansyyt. In: Heikkinen, E and Rantanen, T, eds. *Gerontologia. Duodecim*. Tampere, 2003: 33-47.
- Martelin T, Koskinen S and Valkonen T. Sociodemographic mortality differences among the oldest old in Finland. *J Gerontol B Psychol Sci Soc Sci* 1998;53:S83-90.
- Mattila K, Haavisto M, Rajala S and Heikinheimo R. Blood pressure and five year survival in the very old. *Br Med J (Clin Res Ed)* 1988;296:887-9.
- McDonagh TA, Morrison CE, Lawrence A, Ford I, Tunstall-Pedoe H, McMurray JJ and Dargie HJ. Symptomatic and asymptomatic left-ventricular systolic dysfunction in an urban population. *Lancet* 1997;350:829-33.
- McKee PA, Castelli WP, McNamara PM and Kannel WB. The natural history of congestive heart failure: the Framingham study. *N Engl J Med* 1971;285:1441-6.
- McMurray J, McDonagh T, Morrison CE and Dargie HJ. Trends in hospitalization for heart failure in Scotland 1980-1990. *Eur Heart J* 1993;14:1158-62.
- McWhinnie JR. Disability assessment in population surveys: results of the O.E.C.D. Common Development Effort. *Rev Epidemiol Sante Publique* 1981;29:413-9.
- Miettinen H, Salomaa V, Ketonen M, Niemelä M, Immonen-Räihä P and Mähönen M. Trends in the treatment of patients with myocardial infarction and coronary revascularization procedures in Finland during 1986–92: the FINMONICA Myocardial Infarction Register Study. *J Intern Med* 1999;245:11-20.
- Miles WM and Zipes DP. Coronary heart disease. In: Andreoli, TE, Carpenter, CCJ, Plum, F and Smith, LHJ, eds. *Cecil Essentials of Medicine*. W.B. Saunders Company. Philadelphia, 1990: 63-80.
- Mosterd A, D’Agostino RB, Silbershatz H, Sytkowski PA, Kannel WB, Grobbee DE and Levy D. Trends in the prevalence of hypertension, antihypertensive therapy, and left ventricular hypertrophy from 1950 to 1989. *N Engl J Med* 1999a;340:1221-7.
- Mosterd A, Hoes AW, de Bruyne MC, Deckers JW, Linker DT, Hofman A and Grobbee DE. Prevalence of heart failure and left ventricular dysfunction in the general population; The Rotterdam Study. *Eur Heart J* 1999b;20:447-55.
- Muntner P, Garrett E, Klag MJ and Coresh J. Trends in stroke prevalence between 1973 and 1991 in the US population 25 to 74 years of age. *Stroke* 2002;33:1209-13.
- Murabito JM, Evans JC, Larson MG and Levy D. Prognosis after the onset of coronary heart disease. An investigation of differences in outcome between the sexes according to initial coronary disease presentation. *Circulation* 1993;88:2548-55.
- Murdoch DR, Love MP, Robb SD, McDonagh TA, Davie AP, Ford I, Capewell S, Morrison CE and McMurray JJ. Importance of heart failure as a cause of death. Changing contribution to overall mortality and coronary heart disease mortality in Scotland 1979-1992. *Eur Heart J* 1998;19:1829-35.

- Murray CJL and Lopez AD. Alternative visions of the future: projecting mortality and disability, 1990–2020. In: Murray, CJL and Lopez, AD, eds. The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020. Global Burden of Disease and Injury Series. Volume I. World Health Organization. Geneva, 1996: 325-95.
- Mähönen M, Salomaa V, Keskimäki I and Moltchanov V. The feasibility of routine mortality and morbidity register data linkage to study the occurrence of acute coronary heart disease events in Finland. The Finnish Cardiovascular Diseases Registers (CVDR) Project. *Eur J Epidemiol* 2000;16:701-11.
- Mähönen M, Salomaa V, Torppa J, Miettinen H, Pyörälä K, Immonen-Räihä P, Niemelä M, Ketonen M, Arstila M, Kaarsalo E, Lehto S, Mustaniemi H, Palomäki P, Puska P, Vuorenmaa T and Tuomilehto J. The validity of the routine mortality statistics on coronary heart disease in Finland: comparison with the FINMONICA MI register data for the years 1983–1992. Finnish multinational MONItoring of trends and determinants in CARDiovascular disease. *J Clin Epidemiol* 1999;52:157-66.
- Mähönen M, Sarti C, Brommels M, Molarius A, Salomaa V, Sivenius J and Immonen-Räihä P. Aivoverisuonisairauksien sairaalahoidot Suomessa vuosina 1981–1990. *Suom Lääkäril* 1994;49:1616-9.
- Mäkelä M, Heliövaara M, Sievers K, Knekt P, Maatela J and Aromaa A. Musculoskeletal disorders as determinants of disability in Finns aged 30 years or more. *J Clin Epidemiol* 1993;46:549-59.
- Männistö S, Lahti-Koski M, Tapanainen H, Laatikainen T and Vartiainen E. Lihavuus ja sen taustat Suomessa – liikakilot kasvavana haasteena (Obesity – a challenge also in Finland; in Finnish with English summary). *Suom Lääkäril* 2004;59:777-81.
- Nagi SZ. An epidemiology of disability among adults in the United States. *Milbank Mem Fund Q Health Soc* 1976;54:439-67.
- Nagi SZ. Disability concepts revised: Implications for prevention. In: Pope, AM and Tarlov, AR, eds. *Disability in America: Toward a national agenda for prevention*. National Academy Press. Washington D.C., 1991: 309-27.
- National Public Health Institute. Register of Cardiovascular Diseases. Available at: <http://www3.ktl.fi/stat/> Accessed April 5, 2004.
- Nickel JT and Chirikos TN. Functional disability of elderly patients with long-term coronary heart disease: a sex-stratified analysis. *J Gerontol* 1990;45:S60-8.
- Niinistö L, Verkkoniemi A and Sulkava R. Vantaan vanhimmat. Tutkimus Vantaan kaupungin yli 85-vuotiaiden toimintakyvystä, palveluiden tarpeesta ja sairauksista. Vantaan kaupunki, sosiaali- ja terveystieteiden tutkimuskeskus C:4. 1996.
- Noro A, Häkkinen U and Arinen S. Ikääntyvien suomalaisten terveys, toimintakyky ja sosiaali- ja terveyspalvelujen käyttö vuonna 1996 – Tutkimustuloksia laitoksissa ja kotona asuvasta väestöstä (Health, functional ability and use of health and social services among ageing Finns in 1996 – Findings of surveys of persons living in long-term care institutions and at home; in Finnish with English summary and tables). National Research and Development Centre for Welfare and Health and The Social Insurance Institution, Finland, publication series Health Care 2000:2. Helsinki, 2000.



- Numminen H, Kotila M, Waltimo O, Aho K and Kaste M. Declining incidence and mortality rates of stroke in Finland from 1972 to 1991. Results of three population-based stroke registers. *Stroke* 1996;27:1487-91.
- Ostbye T, Steenhuis R, Wolfson C, Walton R and Hill G. Predictors of five-year mortality in older Canadians: the Canadian Study of Health and Aging. *J Am Geriatr Soc* 1999;47:1249-54.
- Ostir GV, Carlson JE, Black SA, Rudkin L, Goodwin JS and Markides KS. Disability in older adults. 1: Prevalence, causes, and consequences. *Behav Med* 1999;24:147-56.
- Palomäki P, Lehto S, Miettinen H, Salomaa V, Mähönen M, Torppa J, Mustaniemi H, Tuomilehto J and Pyörälä K. FINMONICA-tutkimusten tuloksia II. Sepelvaltimotautikohtausten sairaalahoidot 1980-luvulla. *Suom Lääkäril* 1993;48:3465-9.
- Pasquali SK, Alexander KP and Peterson ED. Cardiac rehabilitation in the elderly. *Am Heart J* 2001;142:748-55.
- Piha T, Niemensivu H and Puska P. Suomalaisen aikuisväestön terveystiettyminen kevät 1986 (Health behaviour among Finnish adult population spring 1986; in Finnish). *Kansanterveyslaitoksen julkaisuja B4/1986*. Helsinki, 1986.
- Pinsky JL, Jette AM, Branch LG, Kannel WB and Feinleib M. The Framingham Disability Study: relationship of various coronary heart disease manifestations to disability in older persons living in the community. *Am J Public Health* 1990;80:1363-7.
- Pisa Z and Uemura K. Trends of mortality from ischaemic heart disease and other cardiovascular diseases in 27 countries, 1968–1977. *World Health Stat Q* 1982; 35:11-47.
- Pitkälä KH, Valvanne J, Kulp S, Strandberg TE and Tilvis RS. Secular trends in self-reported functioning, need for assistance and attitudes towards life: 10-year differences of three older cohorts. *J Am Geriatr Soc* 2001;49:596-600.
- Plum F and Posner JB. Cerebrovascular disease. In: Andreoli, TE, Carpenter, CCJ, Plum, F and Smith, LHJ, eds. *Cecil Essentials of Medicine*. W. B. Saunders Company. Philadelphia, 1990: 766-80.
- Pohjolainen P, Heikkinen E, Lyyra AL, Helin S and Tyrkkö K. Socio-economic status, health and life-style in two elderly cohorts in Jyväskylä. *Scand J Soc Med Suppl* 1997;52:1-65.
- Port S, Demer L, Jennrich R, Walter D and Garfinkel A. Systolic blood pressure and mortality. *Lancet* 2000;355:175-80.
- Puska P, Piha T and Smolander A. Suomalaisen aikuisväestön terveystiettyminen kevät 1983. *Kansanterveyslaitoksen julkaisuja B2/1983*. Helsinki, 1983.
- Pyörälä K, Palomäki P, Miettinen H, Mustaniemi H, Salomaa V and Valkonen T. Decline in coronary heart disease mortality in Finland: effect on age and gender distribution of the disease. *Am J Geriatr Cardiol* 1994;3:20-32.
- Raina P, Dukeshire S, Lindsay J and Chambers LW. Chronic conditions and disabilities among seniors: an analysis of population-based health and activity limitation surveys. *Ann Epidemiol* 1998;8:402-9.
- Rajala SA, Kanto AJ, Haavisto MV, Kaarela RH, Koivunen MJ and Heikinheimo RJ. Body weight and the three-year prognosis in very old people. *Int J Obes* 1990;14: 997-1003.

- Ramos LR, Simoes EJ and Albert MS. Dependence in activities of daily living and cognitive impairment strongly predicted mortality in older urban residents in Brazil: a 2-year follow-up. *J Am Geriatr Soc* 2001;49:1168-75.
- Reitsma JB, Dalstra JA, Bonsel GJ, van der Meulen JH, Koster RW, Gunning-Schepers LJ and Tijssen JG. Cardiovascular disease in the Netherlands, 1975 to 1995: decline in mortality, but increasing numbers of patients with chronic conditions. *Heart* 1999;82:52-6.
- Reitsma JB, Mosterd A, de Craen AJ, Koster RW, van Capelle FJ, Grobbee DE and Tijssen JG. Increase in hospital admission rates for heart failure in The Netherlands, 1980-1993. *Heart* 1996;76:388-92.
- Remes J, Miettinen H, Reunanen A and Pyörälä K. Validity of clinical diagnosis of heart failure in primary health care. *Eur Heart J* 1991;12:315-21.
- Remes J, Reunanen A, Aromaa A and Pyörälä K. Incidence of heart failure in eastern Finland: a population-based surveillance study. *Eur Heart J* 1992;13:588-93.
- Remme WJ and Swedberg K. Guidelines for the diagnosis and treatment of chronic heart failure. *Eur Heart J* 2001;22:1527-60.
- Reuben DB, Siu AL and Kimpau S. The predictive validity of self-report and performance-based measures of function and health. *J Gerontol* 1992;47:M106-10.
- Reunanen A. Sepelvaltimotaudin rintakipuoireiden yleisyys ja ennuste väestössä. Prevalence and prognosis of chest pain suggesting coronary heart disease in middle-aged Finnish men and women. (in Finnish with English summary). Publications of the Social Insurance Institute AL:8. Helsinki, 1977.
- Reunanen A. Tyypin 2 diabetes – uusi maailmanlaajuinen epidemia (Type 2 diabetes – a new global epidemic, in Finnish). *Duodecim* 2003;119:1409-10.
- Reunanen A, Aromaa A and Pyörälä K. Sepelvaltimotauti ja sen vaaratekijät Suomessa. *Duodecim* 1991;107:1187-200.
- Reunanen A, Aromaa A, Pyörälä K, Punsar S, Maatela J and Knekt P. The Social Insurance Institution's coronary heart disease study. Baseline data and 5-year mortality experience. *Acta Med Scand Suppl* 1983;673:1-120.
- Rich MW. Epidemiology, pathophysiology, and etiology of congestive heart failure in older adults. *J Am Geriatr Soc* 1997;45:968-74.
- Robine JM, Romieu I and Cambois E. Health expectancy indicators. *Bull World Health Organ* 1999;77:181-5.
- Romo M. Factors related to sudden death in acute ischaemic heart disease. A community study in Helsinki. *Acta Med Scand Suppl* 1972;547:1-92.
- Romo M, Koskenvuo M, Kaprio J, Langinvainio H and Pulkkinen P. Incidence and prognosis of ischemic heart disease with respect to geographical area. An epidemiological study of middle-aged Finns. *Acta Med Scand* 1982;212:355-60.
- Rosamond WD, Chambless LE, Folsom AR, Cooper LS, Conwill DE, Clegg L, Wang CH and Heiss G. Trends in the incidence of myocardial infarction and in mortality due to coronary heart disease, 1987 to 1994. *N Engl J Med* 1998;339:861-7.
- Rose GA and Blackburn H. Cardiovascular Survey Methods. World Health Organization. Geneva, 1968.
- Rosow I and Breslau N. A Guttman health scale for the aged. *J Gerontol* 1966;21:556-9.

- Ruikka I, Aalto T, Juva K, Kallio V, Konu V, Kuusela V, Mattila K, Ojala T, Seppänen A, Sourander L and Tarkkanen P. Turun vanhusten terveydentila vuonna 1983 (The health of the aged in Turku 1983; in Finnish with English abstract). Kansaneläkelaitoksen julkaisuja/Publications of the Social Insurance Institution ML:43. Turku, 1984.
- Sairanen S, Niinistö L and Tilvis R. Vantaalaisten 65-vuotiaiden terveydentila ja toimintakyky. Vantaan kaupungin sosiaali- ja terveysturvaston julkaisuja C:3. 1993.
- Sakari-Rantala R, Era P, Heikkinen E, Heikkinen R-L, Laukkanen P, Ruoppila I, Suominen H and Suutama T. Iäkkäiden toimintakyky- ja terveystutkimus. Kahden keskiuomalaisen 75-vuotiaan väestöryhmän vertailu (Evaluating functional capacity and health of elderly people in two populations; in Finnish with English summary). Kansaneläkelaitos, Sosiaali- ja terveysturvan tutkimuksia 2. Helsinki, 1995.
- Salomaa V, Arstila M, Kaarsalo E, Ketonen M, Kuulasmaa K, Lehto S, Miettinen H, Mustaniemi H, Niemelä M and Palomäki P. Trends in the incidence of and mortality from coronary heart disease in Finland, 1983-1988. *Am J Epidemiol* 1992;136:1303-15.
- Salomaa V, Ketonen M, Koukkunen H, Immonen-Räihä P, Jerkkola T, Karja-Koskenkari P, Mähönen M, Niemelä M, Kuulasmaa K, Palomäki P, Arstila M, Vuorenmaa T, Lehtonen A, Lehto S, Miettinen H, Torppa J, Tuomilehto J, Kesäniemi YA and Pyörälä K. Trends in coronary events in Finland during 1983-1997. The FINAMI study. *Eur Heart J* 2003;24:311-9.
- Salomaa V, Miettinen H, Kuulasmaa K, Niemelä M, Ketonen M, Vuorenmaa T, Lehto S, Palomäki P, Mähönen M, Immonen-Räihä P, Arstila M, Kaarsalo E, Mustaniemi H, Torppa J, Tuomilehto J, Puska P and Pyörälä K. Decline of coronary heart disease mortality in Finland during 1983 to 1992: roles of incidence, recurrence, and case-fatality. The FINMONICA MI Register Study. *Circulation* 1996a;94:3130-7.
- Salomaa V, Miettinen H, Palomäki P, Arstila M, Mustaniemi H, Kuulasmaa K and Tuomilehto J. Diagnostic features of acute myocardial infarction—changes over time from 1983 to 1990: results from the FINMONICA AMI Register Study. *J Intern Med* 1995;237:151-9.
- Salomaa V, Rosamond W and Mähönen M. Decreasing mortality from acute myocardial infarction: effect of incidence and prognosis. *J Cardiovasc Risk* 1999;6:69-75.
- Salomaa V, Tamminen M, Salmela R, Keskimäki I, Hämäläinen H and Reunanen A. The Occurrence of Coronary Heart Disease in Finland 1991–1994. Publications of the National Public Health Institute B11/1996. Helsinki, 1996b.
- Salomaa V, Tamminen M, Salmela R, Keskimäki I, Hämäläinen H and Reunanen A. The Occurrence of Stroke in Finland 1991–1994. Publications of the National Public Health Institute B10/1996. Helsinki, 1996c.
- Sans S, Kesteloot H and Kromhout D. The burden of cardiovascular diseases mortality in Europe. Task Force of the European Society of Cardiology on Cardiovascular Mortality and Morbidity Statistics in Europe. *Eur Heart J* 1997;18:1231-48.
- Sarti C, Rastenyte D, Cepaitis Z and Tuomilehto J. International trends in mortality from stroke, 1968 to 1994. *Stroke* 2000;31:1588-601.

- Sarti C, Stegmayr B, Tolonen H, Mähönen M, Tuomilehto J and Asplund K. Are changes in mortality from stroke caused by changes in stroke event rates or case fatality? Results from the WHO MONICA Project. *Stroke* 2003;34:1833-40.
- Sarti C, Tuomilehto J, Sivenius J, Kaarsalo E, Narva EV, Salmi K, Torppa J and Salomaa V. Declining trends in incidence, case-fatality and mortality of stroke in three geographic areas of Finland during 1983-1989. Results from the FINMONICA stroke register. *J Clin Epidemiol* 1994;47:1259-69.
- Sauli H, Ahola A, Lahelma E and Savolainen J. Elinolot numeroina. Vuoden 1986 elinolotutkimus. Tilastokeskus, julkaisusarja Elinolot 1989:1. Helsinki, 1989.
- Schreiner PJ, Niemelä M, Miettinen H, Mähönen M, Ketonen M, Immonen-Räihä P, Lehto S, Vuorenmaa T, Palomäki P, Mustaniemi H, Kaarsalo E, Arstila M, Torppa J, Puska P, Tuomilehto J, Pyörälä K and Salomaa V. Gender differences in recurrent coronary events: The FINMONICA MI register. *Eur Heart J* 2001;22:762-8.
- Scott WK, Macera CA, Cornman CB and Sharpe PA. Functional health status as a predictor of mortality in men and women over 65. *J Clin Epidemiol* 1997;50:291-6.
- Senni M, Tribouilloy CM, Rodeheffer RJ, Jacobsen SJ, Evans JM, Bailey KR and Redfield MM. Congestive heart failure in the community: trends in incidence and survival in a 10-year period. *Arch Intern Med* 1999;159:29-34.
- Sigurdsson E, Thorgeirsson G, Sigvaldason H and Sigfusson N. Prevalence of coronary heart disease in Icelandic men 1968-1986. The Reykjavik Study. *Eur Heart J* 1993;14:584-91.
- Sihvonen A-P, Martelin T, Koskinen S, Sainio P and Aromaa A. Sairastavuus ja toimintakykyinen elinaika. In: Heikkinen, E and Rantanen, T, eds. *Gerontologia*. Duodecim. Helsinki, 2003: 48-59.
- Sivenius J, Tuomilehto J, Immonen-Räihä P, Kaarisalo M, Sarti C, Torppa J, Kuulasmaa K, Mähönen M, Lehtonen A and Salomaa V. Continuous 15-year decrease in incidence and mortality of stroke in Finland: the FINSTROKE study. *Stroke* 2004; 35:420-5.
- Spertus JA, Jones P, McDonell M, Fan V and Fihn SD. Health status predicts long-term outcome in outpatients with coronary disease. *Circulation* 2002;106:43-9.
- Stamler J, Stamler R and Neaton JD. Blood pressure, systolic and diastolic, and cardiovascular risks. US population data. *Arch Intern Med* 1993;153:598-615.
- Statistics Finland. Causes of death 1994. Statistics Finland, Publication series Health 1996:1. Helsinki, 1996.
- Statistics Finland. Causes of death 1996. Statistics Finland, Publication series Health 1998:3. Helsinki, 1998.
- Statistics Finland. Causes of death 2002. Statistics Finland, Publication series Health 2003:2. Helsinki, 2003a.
- Statistics Finland. Statistical Yearbook of Finland 2003. Statistics Finland. Helsinki, 2003b.
- Stewart AL, Greenfield S, Hays RD, Wells K, Rogers WH, Berry SD, McGlynn EA and Ware JE, Jr. Functional status and well-being of patients with chronic conditions. Results from the Medical Outcomes Study [erratum appears in JAMA 1989 Nov 10;262(18):2542]. *JAMA* 1989;262:907-13.

- Stewart S, MacIntyre K, MacLeod MM, Bailey AE, Capewell S and McMurray JJ. Trends in hospitalization for heart failure in Scotland, 1990–1996. An epidemic that has reached its peak? *Eur Heart J* 2001;22:209-17.
- Strandberg A, Strandberg TE, Salomaa V, Pitkälä K, Häppölä O and Miettinen TA. A follow-up study found that cardiovascular risk in middle age predicted mortality and quality of life in old age. *J Clin Epidemiol* 2004;(in press).
- Strandberg TE, Pitkälä K, Berglind S, Nieminen MS and Tilvis RS. Multifactorial cardiovascular disease prevention in patients aged 75 years and older: A randomized controlled trial: Drugs and Evidence Based Medicine in the Elderly (DEBATE) Study. *Am Heart J* 2001a;142:945-51.
- Strandberg TE, Salomaa VV, Vanhanen HT and Pitkälä K. Blood pressure and mortality during an up to 32-year follow-up. *J Hypertens* 2001b;19:35-9.
- Strawbridge WJ, Kaplan GA, Camacho T and Cohen RD. The dynamics of disability and functional change in an elderly cohort: results from the Alameda County Study. *J Am Geriatr Soc* 1992;40:799-806.
- Stuck AE, Walthert JM, Nikolaus T, Bula CJ, Hohmann C and Beck JC. Risk factors for functional status decline in community-living elderly people: a systematic literature review. *Soc Sci Med* 1999;48:445-69.
- Sulander T, Helakorpi S, Nissinen A and Uutela A. Eläkeikäisen väestön terveyskäyttäytyminen keväällä 2001 ja sen muutokset 1993–2001 (Health Behaviour and Health among Finnish Elderly, Spring 2001, with trends 1993–2001; in Finnish with English summary and tables). Publications of the National Public Health Institute, B17/2001. Helsinki, 2001.
- Sulander T, Helakorpi S, Rahkonen O, Nissinen A and Uutela A. Changes and associations in healthy diet among the Finnish elderly, 1985–2001. *Age Ageing* 2003;32:394-400.
- Sullivan M, LaCroix A, Baum C, Resnick A, Pabiniak C, Grothaus L, Katon W and Wagner E. Coronary disease severity and functional impairment: how strong is the relation? *J Am Geriatr Soc* 1996;44:1461-5.
- Suomen Verenpaineyhdistys ry:n asettama työryhmä. Kohonneen verenpaineen hoito. Käypä hoito -suositus. *Duodecim* 2002;118:110-26.
- Swahn E. The care of patients with ischaemic heart disease from a gender perspective. *Eur Heart J* 1998;19:1758-65.
- The TIME investigators. Trial of invasive versus medical therapy in elderly patients with chronic symptomatic coronary-artery disease (TIME): a randomised trial. *Lancet* 2001;358:951-7.
- Thom TJ. Stroke mortality trends. An international perspective. *Ann Epidemiol* 1993;3:509-18.
- Thom TJ and Epstein FH. Heart disease, cancer, and stroke mortality trends and their interrelations. An international perspective. *Circulation* 1994;90:574-82.
- Thorvaldsen P, Davidsen M, Bronnum-Hansen H and Schroll M. Stable stroke occurrence despite incidence reduction in an aging population: stroke trends in the danish monitoring trends and determinants in cardiovascular disease (MONICA) population. *Stroke* 1999;30:2529-34.

- Tolonen H, Mähönen M, Asplund K, Rastenyte D, Kuulasmaa K, Vanuzzo D and Tuomilehto J. Do trends in population levels of blood pressure and other cardiovascular risk factors explain trends in stroke event rates? Comparisons of 15 populations in 9 countries within the WHO MONICA Stroke Project. *World Health Organization Monitoring of Trends and Determinants in Cardiovascular Disease. Stroke* 2002;33:2367-75.
- Truelsen T, Mähönen M, Tolonen H, Asplund K, Bonita R and Vanuzzo D. Trends in stroke and coronary heart disease in the WHO MONICA Project. *Stroke* 2003; 34:1346-52.
- Tunstall-Pedoe H. Is Acute Coronary Heart Disease Different in Different Countries in the Two Sexes: Lessons from the MONICA Project. *Cardiovasc Risk Fact* 1996;6:254-61.
- Tunstall-Pedoe H, Kuulasmaa K, Amouyel P, Arveiler D, Rajakangas AM and Pajak A. Myocardial infarction and coronary deaths in the World Health Organization MONICA Project. Registration procedures, event rates, and case-fatality rates in 38 populations from 21 countries in four continents. *Circulation* 1994;90:583-612.
- Tunstall-Pedoe H, Kuulasmaa K, Mähönen M, Tolonen H, Ruokokoski E and Amouyel P. Contribution of trends in survival and coronary-event rates to changes in coronary heart disease mortality: 10-year results from 37 WHO MONICA project populations. Monitoring trends and determinants in cardiovascular disease. *Lancet* 1999; 353:1547-57.
- Tunstall-Pedoe H, Vanuzzo D, Hobbs M, Mähönen M, Cepaitis Z, Kuulasmaa K and Keil U. Estimation of contribution of changes in coronary care to improving survival, event rates, and coronary heart disease mortality across the WHO MONICA Project populations. *Lancet* 2000;355:688-700.
- Tuomilehto J, Arstila M, Kaarsalo E, Kankaanpää J, Ketonen M, Kuulasmaa K, Lehto S, Miettinen H, Mustaniemi H, Palomäki P and et al. Acute myocardial infarction (AMI) in Finland—baseline data from the FINMONICA AMI register in 1983-1985. *Eur Heart J* 1992;13:577-87.
- Tuomilehto J and Kuulasmaa K. WHO MONICA Project: assessing CHD mortality and morbidity. *Int J Epidemiol* 1989;18:S38-45.
- Tuomilehto J, Rastenyte D, Sivenius J, Sarti C, Immonen-Räihä P, Kaarsalo E, Kuulasmaa K, Narva EV, Salomaa V, Salmi K and Torppa J. Ten-year trends in stroke incidence and mortality in the FINMONICA Stroke Study. *Stroke* 1996;27:825-32.
- Tyrkkö A. Elinolot numeroina 1994. Tilastokeskus, julkaisusarja Elinolot 1996:1. Helsinki, 1996.
- Uemura K and Pisa Z. Trends in cardiovascular disease mortality in industrialized countries since 1950. *World Health Stat Q* 1988;41:155-78.
- Uutela A, Helakorpi S and Puska P. Eläkeikäisen väestön terveystäyttyminen, keväällä 1997 ja sen muutokset 1993–97 (Health behavior among Finnish Elderly, Spring 1997 with trends 1993–97; in Finnish with English summary and tables). Publications of the National Public Health Institute B5/1999. Helsinki, 1999.
- Vaccarino V, Berkman LF, Mendes de Leon CF, Seeman TE, Horwitz RI and Krumholz HM. Functional disability before myocardial infarction in the elderly as a determinant of infarction severity and postinfarction mortality. *Arch Intern Med* 1997;157:2196-204.



- Waidmann TA and Liu K. Disability trends among elderly persons and implications for the future. *J Gerontol B Psychol Sci Soc Sci* 2000;55:S298-307.
- Valkonen T, Martelin T, Rimpelä A, Notkola V and Savela S. Socio-economic mortality differences in Finland 1981-90. Statistics Finland, Publication series Population 1. Helsinki, 1993.
- Valvanne J, Erkinjuntti T and Tilvis R. Helsingin vanhustutkimus. Helsingkiläisten 75-, 80- ja 85-vuotiaiden terveydentila, toimintakyky ja terveystalvelujen tarve vuonna 1989. Helsingin kaupungin terveystalvelujen raportteja, sarja A, raportti 71. Helsinki, 1992.
- van den Hoogen PC, Feskens EJ, Nagelkerke NJ, Menotti A, Nissinen A and Kromhout D. The relation between blood pressure and mortality due to coronary heart disease among men in different parts of the world. Seven Countries Study Research Group. *N Engl J Med* 2000;342:1-8.
- van Jaarsveld CH, Sanderman R, Miedema I, Ranchor AV and Kempen GI. Changes in health-related quality of life in older patients with acute myocardial infarction or congestive heart failure: a prospective study. *J Am Geriatr Soc* 2001;49:1052-8.
- van Jaarsveld CH, Sanderman R, Ranchor AV, Ormel J, van Veldhuisen DJ and Kempen GI. Gender-specific changes in quality of life following cardiovascular disease: a prospective study. *J Clin Epidemiol* 2002;55:1105-12.
- Vartiainen E, Jousilahti P, Alfthan G, Sundvall J, Pietinen P and Puska P. Cardiovascular risk factor changes in Finland, 1972-1997. *Int J Epidemiol* 2000;29:49-56.
- Vartiainen E, Jousilahti P, Juolevi A, Sundvall J, Alfthan G, Salminen I and Puska P. FINRISKI 1997. Tutkimus kroonisten kansantautien riskitekijöistä, niihin liittyvistä elintavoista, oireista ja terveystalvelujen käytöstä. Publications of the National Public Health Institute B1/1998. Helsinki, 1998.
- Vartiainen E, Laatikainen T, Tapanainen H, Salomaa V, Jousilahti P, Sundvall J, Salminen M, Männistö S and Valsta L. Suomalaisten sydän- ja verisuonitautien riskitekijät FINRISKI-tutkimuksessa 1982-2002 (Changes in cardiovascular risk factors in Finland in the National FINRISK Study between 1982 and 2002; in Finnish with English summary). *Suom Lääkäril* 2003;58:4099-106.
- Vartiainen E, Puska P, Jousilahti P, Korhonen HJ, Tuomilehto J and Nissinen A. Twenty-year trends in coronary risk factors in north Karelia and in other areas of Finland. *Int J Epidemiol* 1994a;23:495-504.
- Vartiainen E, Puska P, Pekkanen J, Tuomilehto J and Jousilahti P. Changes in risk factors explain changes in mortality from ischaemic heart disease in Finland. *BMJ* 1994b;309:23-7.
- Vartiainen E, Sarti C, Tuomilehto J and Kuulasmaa K. Do changes in cardiovascular risk factors explain changes in mortality from stroke in Finland? *BMJ* 1995;310:901-4.
- Vasan RS, Beiser A, Seshadri S, Larson MG, Kannel WB, D'Agostino RB and Levy D. Residual lifetime risk for developing hypertension in middle-aged women and men: The Framingham Heart Study. *JAMA* 2002;287:1003-10.
- Wenger NK. Cardiovascular disease in the elderly. In: Evered, D and Whelan, J, eds. *Research and the Ageing Population*. John Wiley & Sons Ltd. Chichester, 1988: 106-28.

- Wenger NK. An update on coronary heart disease in women. *Int J Fertil Womens Med* 1998;43:84-90.
- Wenger NK. Clinical characteristics of coronary heart disease in women: emphasis on gender differences. *Cardiovasc Res* 2002;53:558-67.
- Verbrugge LM, Lepkowski JM and Imanaka Y. Comorbidity and its impact on disability. *Milbank Q* 1989;67:450-84.
- WHO. Arterial hypertension and ischaemic heart disease. Preventive aspects. WHO Tech Rep Ser No 231. Geneve, 1962.
- Wiener JM, Hanley RJ, Clark R and Van Nostrand JF. Measuring the activities of daily living: comparisons across national surveys. *J Gerontol* 1990;45:S229-37.
- Williams MA, Fleg JL, Ades PA, Chaitman BR, Miller NH, Mohiuddin SM, Ockene IS, Taylor CB and Wenger NK. Secondary prevention of coronary heart disease in the elderly (with emphasis on patients  $\geq$  75 years of age): an American Heart Association scientific statement from the Council on Clinical Cardiology Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention. *Circulation* 2002;105:1735-43.
- Winblad I. Comparison of the prevalence of disability in two birth cohorts at the age of 75 years and over. *J Clin Epidemiol* 1993;46:303-8.
- Winblad I, Jaaskelainen M, Kivela S, Hiltunen P and Laippala P. Prevalence of disability in three birth cohorts at old age over time spans of 10 and 20 years. *J Clin Epidemiol* 2001;54:1019-24.
- Vita AJ, Terry RB, Hubert HB and Fries JF. Aging, health risks, and cumulative disability. *N Engl J Med* 1998;338:1035-41.
- Wolf HK, Tuomilehto J, Kuulasmaa K, Domarkiene S, Cepaitis Z, Molarius A, Sans S, Dobson A, Keil U and Rywik S. Blood pressure levels in the 41 populations of the WHO MONICA Project. *J Hum Hypertens* 1997;11:733-42.
- Woo J, Ho SC, Yu LM, Lau J and Yuen YK. Impact of chronic diseases on functional limitations in elderly Chinese aged 70 years and over: a cross-sectional and longitudinal survey. *J Gerontol A Biol Sci Med Sci* 1998;53:M102-6.
- World Health Organization. International Classification of Impairments, Disabilities, and Handicaps. World Health Organization. Geneva, 1980.
- World Health Organization. International Classification of Functioning, Disability and Health: ICF. World Health Organization. Geneva, 2001.
- World Population Ageing: 1950–2050. United Nations, Department of Economic and Social Affairs, Population Division: ST/ESA/SER.A/207. New York, 2001. Available at: <http://www.un.org/esa/population/publications/worldageing19502050/>.